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A COMPREHENSIVE PROGRAM FOR THE COMPILATION AND ANALYSIS OF THERMAL RADIATIVE PROPERTIES DATA

by D. P. DeWitt, M. C. Muinzer, and R. S. Hernicz

Prepared by
PURDUE UNIVERSITY
West Lafayette, Ind.
for

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PURDUE UNIVERSITY
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for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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FOREWORD

This report was prepared by the Thermophysical Properties Research Center (TPRC), Purdue University, West Lafayette, Indiana, under NASA Contract No. NSR-15-005-037, "Compilation and Analysis of Thermal Radiative Properties Data". The work was administered under the direction of the Office of Advanced Research and Technology, NASA, Washington, D. C., with Mr. Conrad Mook acting as project monitor.

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Dr. D. P. DeWitt has been the major investigator and program director. Mr. M. C. Muinzer has served as coordinator for the group consisting of Dr. R. L. Jones, Mr. R. Hernicz, Dr. J. J. Hsia, Mr. D. Garcev, and Mr. R. Dilling. During his brief affiliation with TPRC, Dr. Jones initiated the data evaluation activities for the Series, Volume 7.

The authors wish to acknowledge the direct contributions of TPRC's Scientific Documentation Division, Dr. C. Y. Ho (Head, Data Tables Division); and the staff of the graphics and typing units.

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ABSTRACT

A frequent obstacle in technical developments is the paucity of knowledge on the properties of materials. While there exists an ever increasing volume of literature on the thermal radiative properties, engineering designers are using only a small fraction of what is already available either because it is in a form not directly useful to them or because its existence is not generally known to them, and such information remains buried in the world's literature.

The program described in this report has the objective to identify, collect, extract and analyze data on the thermal radiative properties for general dissemination. Effort is being concentrated on the technological materials of special interest to aerospace requirements under environmental conditions likely to occur in space application. The results of the program will be disseminated through the TPRC SERIES ON THERMOPHYSICAL PROPERTIES OF MATTER presented in three parts: metallic elements and their alloys, nonmetallic solids, and coatings. Data are presented in tabular and graphical forms with accompanying tables giving specifications for the test specimens. For each material four prime properties are identified - emittance, reflectance, absorptance and transmittance - and further grouped according to geometric conditions (hemispherical, normal and angular) and wavelength conditions (spectral, total, solar, and integrated). When sufficient evidence exists, the data has been analyzed and figures of "recommended" values for specific surface and/or environmental conditions are presented. The first part of the program is nearing completion (metallic elements and alloys) and the second and third parts are now well under way.

INTRODUCTION

The phenomenal growth of science and technology in the last twenty years has brought about a universal appreciation of the fact that present limitations in many technical developments are often a direct result of the paucity of knowledge on the properties of materials. Engineering developments in the years ahead will be closely linked to the research being performed today to contribute to a better understanding of the thermal behavior of materials.

The amount of activity in property determinations, especially thermal radiative properties in the more recent years, attests to the seriousness of the situation with the result that the volume of research literature has increased many fold. Despite the widespread efforts, it can safely be said that the present level of research still falls short of existing needs and anticipated demands. The really disturbing feature is that engineering groups across the nation are using only a small fraction of the information already available, either because it is in a form not directly useful to them or because its existence is not generally known to them and such information remains buried in the world's literature.

There are those who would argue that having full access to the world's literature in a convenient form would not be the total or final solution. Because of the elusive nature of radiative properties - the large influence of surface conditions arising from methods of preparation, thermal history, and environmental conditions - there is little assurance that the data, once located, can be considered reliable or applicable to the problem at hand. This point of view has given rise to a rash of measurement programs necessary for generating data required for specific applications. For the most part, the basic problem - that of gaining insight on how to characterize materials, thereby prescribing the suitability for data to the various applications - has been largely ignored.

Since 1960, the TPRC Retrieval Guide [1]* has provided a key to the world's literature permitting rapid identification of research papers on radiative properties data. While this is the first and most necessary step, it is not the most convenient form for design engineers. Since 1962, using the Retrieval Guide as the starting point, pertinent literature on radiative properties has been

*The numbers in brackets refer to bibliographic citations listed in the section References.

examined and data extracted for the purpose of generating a compendia published as a part of the TPRC Data Book [2]. The program now in progress, and being described in this report, is an extension and enlargement of the modest effort started many years ago.

The current comprehensive program has the objective to concentrate on the technological materials of special interest to aerospace requirements under environmental conditions likely to occur in space applications. The result will be an extensive handbook for design use, containing original research data literature and also "recommended" values for surface and/or environmental conditions that can be well characterized.

This program will bring the world's literature under full and current organizational control. Such a tool, besides giving support to the designers, provides the starting point for further research as the topography of the world's knowledge will make evident the paucities and conflicts in data, as well as provide input for characterization studies using a great bulk of available data. The experience at TPRC using this approach for other properties has been rewarding and significant contributions, particularly in the area of thermal conduction in solids [3], have been made.

SCOPE OF THE PROGRAM

The primary objective of this program is to identify, collect, extract, and analyze data on thermal radiative properties for dissemination to and use by engineering design groups. This task, formidable in both its scope and magnitude, presents difficulties in devising an organizational form suitable and convenient for reference by the many interested users of such data.

The materials of interest include all metals, ceramics (excluding glasses), cermets, and coatings of all types especially those particularly suited for thermal control. The temperature range covers from near absolute zero to the material's melting point as only the solid state is being considered. The wavelength range covers from 500 Å to 1000 μ which encompasses the thermal portion of the spectrum, and special attention is given to solar spectrum conditions.

The thermal radiative properties being presented include the prime properties: emittance, reflectance, absorptance, and transmittance. Additionally, the various sub-properties of these prime ones, denoting geometric and wavelength conditions, are further categorized for efficient retrieval. In as much as the nomenclature for these properties is not universally accepted, it has been necessary to develop a consistent set of terms to unambiguously represent the various sub-properties. For the most part, the nomenclature, fully described in a later section, approximates common usage and lends itself well to the compact and systematic organization required of such a comprehensive work.

The following section of this report deals with the more significant problems in organization of the TPRC SERIES which will be the medium for communication of the information generated by the program.

ORGANIZATION OF THE SERIES

The data on thermal radiative properties will be presented in three volumes of the TPRC SERIES ON THERMOPHYSICAL PROPERTIES OF MATTER:

Volume 7 - Thermal Radiative Properties of Metallic Elements and Alloys

Volume 8 - Thermal Radiative Properties of Nonmetallic Solids

Volume 9 - Thermal Radiative Properties of Coatings

Each volume will have, in addition to a data section, a text portion concerning the theory, estimation and measurement of the thermal radiative properties of the materials covered in that volume. The purpose of this text is to provide tools for the use and understanding of the data section, and should be a unique contribution in that it contains, in some detail, the experience of the TPRC staff in the evaluation and estimation of property values. See Appendix A for the Contents of this text.

Following the text, there will be a section on data presentation and other related information. In this section the classification - properties and materials - systems are defined, along with the symbols and abbreviations used in the figures and tables. Since these systems are extensive, the user of the book will find it

desirable, if not necessary, to become familiar with this section for maximum efficiency of data retrieval.

PROPERTY CLASSIFICATION

The primary radiative properties - emittance, reflectance, absorptance, and transmittance - can all be further specified according to geometric and wavelength conditions. In this SERIES the geometric conditions are denoted by the terms angular, normal, and hemispherical. The wavelength conditions are denoted by the terms spectral, total, integrated and solar.

The definition of the terms and their representation by symbols is presented in Appendix B. This section also discusses the classification scheme for grouping related sub-properties for simplified retrieval by the user. What may at first glance appear to be a cumbersome scheme of unnecessary detail is really quite logical to serve the needs of both the casual and experienced user.

PRESENTATION OF DATA

Elements, Alloys and Compounds

The classification scheme for materials in Volumes 7 and 8 is based upon bulk composition rather than surface chemical composition which varies due to weathering, oxidation, etc. This classification scheme is shown in Table 1 which also illustrates the logic for dividing the materials into two volumes, metallic elements and alloys (Volume 7) and nonmetallic solids (Volume 8).

For each material, sub-property data are separately presented in graphical and tabular form, accompanied by a table presenting details of the test conditions and sample preparation.

The format for the presentation of the thermal radiative properties is designed specifically to supply the reader with the aspects of the properties in a comprehensive yet concise form. Each presentation consists of four sections*; Original Data Plot, Analyzed Data Graph, Specification Tables, and Data Tables, respectively.

*In certain cases, where there exists only a small amount of data, the Original Data Plot and/or the Analyzed Data Graph may be omitted.

TABLE 1. CLASSIFICATION OF MATERIALS

			X_1, %	$X_1 + X_2$, %	X_2, %	X_3, %
1. Metallic Elements and Alloys						
Metallic Elements			>99.5	-----	<0.2	<0.2
Alloys	Binary Alloys		-----	≥99.5	≥0.2	≤0.2
Alloys	Multiple Alloys		-----	≥99.5	>0.2	>0.2
Alloys	Multiple Alloys		-----	<99.5	≥0.2	≤0.2
Alloys	Multiple Alloys		-----	<99.5	>0.2	>0.2
Alloys	Multiple Alloys		≤99.5	-----	<0.2	<0.2
2. Nonmetallic Solids*						
Nonmetallic Elements (or Single Compounds			≥95.0		≤2.0	
Mixtures			<95.0		≤2.0	
Mixtures			≥95.0		>2.0	
Mixtures			<95.0		>2.0	

Nomenclature:

X_1 = Major Constituent
X_2 = Second Highest Constituent
X_3 = Third Highest Constituent
% = Weight Percent

*The compositions of non-metals cannot be determined as accurately as those of metals. Therefore, those percentages indicated only serve as approximate limits.

The Original Data Plot is a graphical representation which presents most of the tabulated data. In overcrowded plots, some of the data which are repetitive in nature are omitted.

The Analyzed Data Graph presents a new and powerful approach to increasing the effectiveness of literature data. It is an evaluative review identifying and "recommending" reliable and/or typical data for various surface and/or environmental conditions. The study considers the interrelationships between the sub-properties to give a consistent set of data. Where the data are well characterized and/or highly reliable, it is represented by a solid curve; where there exists some speculation, the data are represented by dashed lines or a shaded band. Following presentation of selected figures from Volume 7, a brief section discusses this approach of data analysis.

The Specification Table gives the most important information: the curve number correlating the information on the Specification Table with that of the figures and Data Table, the reference number corresponding to the number given in the listed references, the year of the publication from which the data were extracted, independent variable range, parameter(s), geometry (θ, θ', ω, ω') and the error (%) reported by the author.

The Composition (weight percent), Specification, and Remarks section of the Specification Table provides the available information about the specimen and test conditions. The presentation is standardized in this order:

1. trade name
2. composition (weight percent)
3. film or foil thickness
4. specimen preparation processes
5. surface condition (roughness, etc.)
6. environment
7. type of original presentation of the data (smooth curve, etc.)
8. reference standard
9. other pertinent information
10. author's designation

Following the Specification Table is the Data Table, a tabular presentation of the property values shown on the Figure and described in the Specification Tables.

Coatings

Considerable effort has been given during the past year to the organization of information on coatings. The term "coatings" is a general one and elusive to define. In the context of the SERIES, a coating is a system consisting of a layer (or layers) of any substance(s) upon a substrate. Of interest are all types of coatings used for many applications - covering protection, finishing, thermal control, etc.

Consideration was given to grouping by application, methods of preparation, and durability. Discussions were held with numerous national experts concerning potential classification systems based on different aspects of coatings. Considering suggestions in light of the purpose for which the SERIES was intended, four major groups of coatings have been delineated which are defined in Table 2.

It should be stressed that this system is still being studied for areas of improvement and that as more data are studied in detail, further analysis of the system structure will be possible.

In processing papers on coatings, it is necessary to include more information in the Specification Tables than is required for the non-coatings. In addition, the following parameters if available are given:

1. thickness of coating
2. substrate
3. condition of substrate
4. application technique
5. environmental effects
6. catalyst (paints)
7. pigment-vehicle ratio (paints)
8. properties of coating (viscosity, porosity, etc.)
9. other pertinent information given by author

Special emphasis will be given to environmental conditions before and during measurements.

TABLE 2. CLASSIFICATION OF COATINGS

Conversion - Diffusion Coatings

A layer of a compound, or mixture of compounds formed by the chemical reaction of the substrate with another material. Classified alphabetically by substrate. Examples:

a. Anodized Aluminum
b. Durak B
c. Oxidized Inconel 702

Contact Coatings

A layer, or layers, of a substance coated on a substrate without a chemical reaction occurring between the coating material and the substrate. Classified alphabetically by coating material itself. Subdivided into the following three types, with examples:

1. Inorganic
   a. Alclad Aluminum
   b. Flame-sprayed Al_2O_3
   c. Evaporated Gold Film
2. Organic
   a. Teflon
   b. Vinyl
3. Special Purpose
   a. Anti-reflection Coatings
   b. Second Surface Mirrors

Pigmented Coatings (Vitreous enamels and paints)

A mixture of pigment and vehicle applied to a substrate. Classified alphabetically by pigment. Subdivided into the following three types, with examples:

1. Inorganic Pigment
   a. Paint (Sb_2O_3 + nitrocellulose)
   b. Paint (TiO_2 + epoxy resin)
   c. Paint (ZnO + silicone)
2. Organic Pigment
   a. Paint (Vinyl-phenolic)
3. Miscellaneous Paints
   a. Dynalac H-U
   b. Korotherm HT
   c. Colors

Uncharacterized Coatings

Classified alphabetically by commercial name.

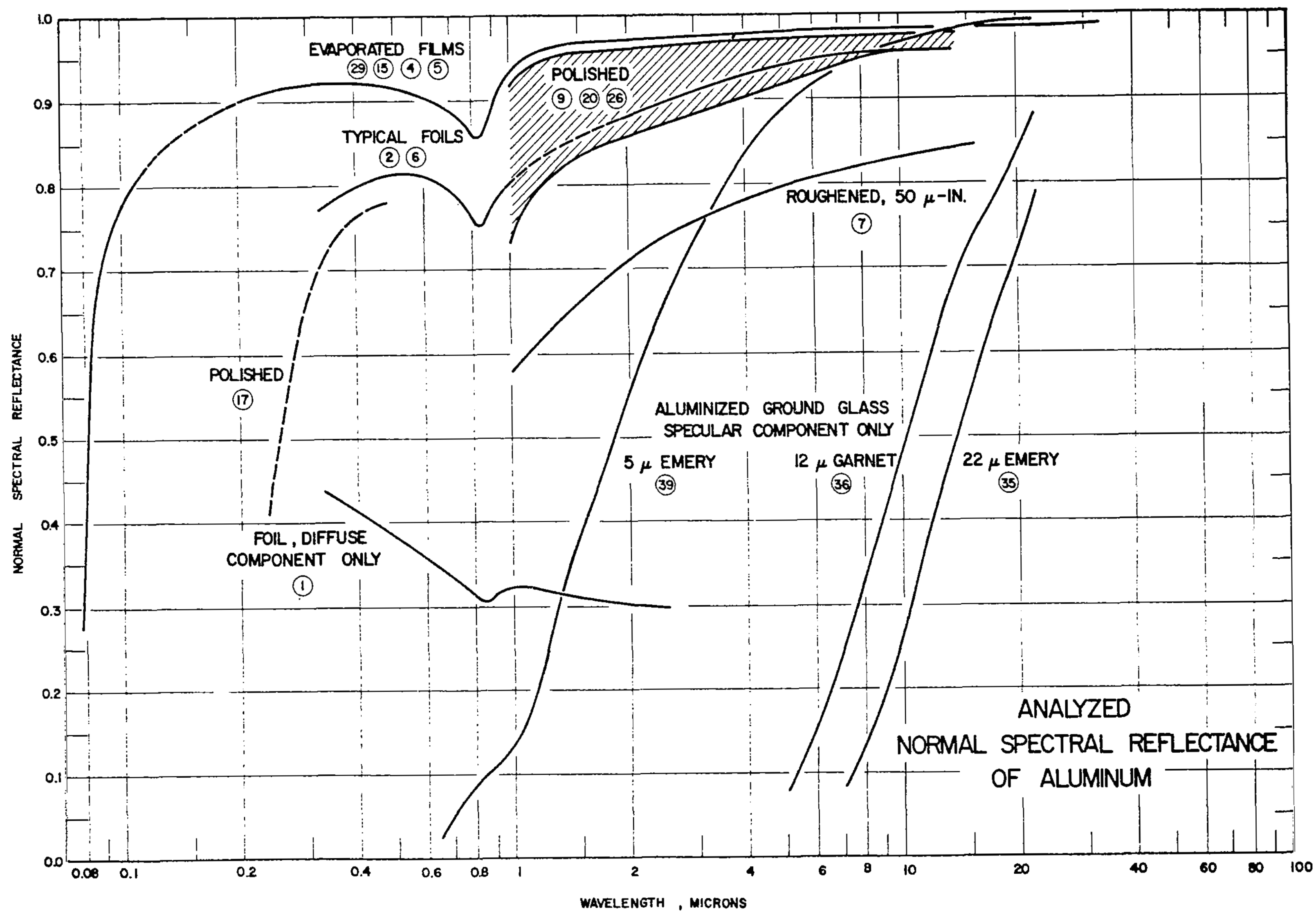
MATERIAL INDEX AND REFERENCE LISTINGS

The Material Index is an alphabetical listing of all materials contained in the SERIES volume together with their respective page numbers for each sub-property. Many commercial designations are cross-indexed with their previous designations and synonyms for complete retrieval of the desired data. The Material Index and Grouping of Materials and List of Figures and Tables from Volume 7 is given in Appendix C.

The bibliographic citation for each reference number is furnished in the numerically ordered list of references at the end of the book. Appendix D contains the Reference listing from Volume 7.

SAMPLE FIGURES, SPECIFICATION AND DATA TABLES

The following pages contain several selected sets of Figures, Specification and Data Tables for the purpose of demonstrating the presentation of data in the TPRC SERIES, Volume 7. Included are the following:



ANALYZED
NORMAL SPECTRAL REFLECTANCE
OF ALUMINUM

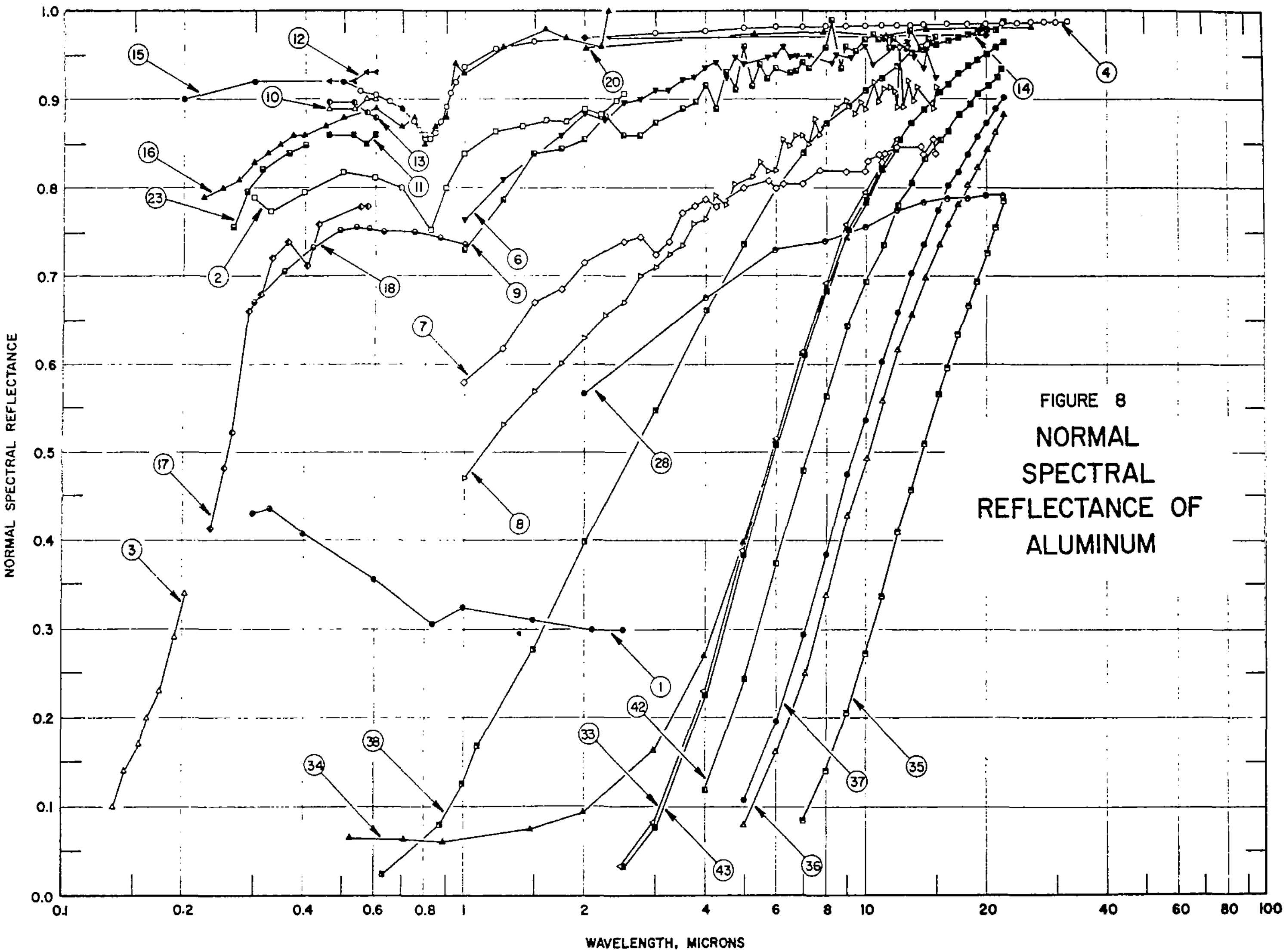


FIGURE 8
NORMAL SPECTRAL REFLECTANCE OF ALUMINUM

SPECIFICATION TABLE NO. 8   NORMAL SPECTRAL REFLECTANCE OF ALUMINUM

Curve No.	Ref. No.	Year	Temperature K	Wavelength Range, μ	Geometry θ	Geometry θ' ω'	Reported Error, %	Composition (weight percent), Specifications and Remarks
1	123	1960	298	0.30-2.50	$\sim 0°$	2π		Foil; MgO reference; diffuse reflectance.
2	123	1960	298	0.30-2.50	$\sim 0°$	2π		Foil; cemented on fiberglass laminate; MgO reference.
3	124	1941	298	0.1347-0.2026	$\sim 0°$	$\sim 0°$		An opaque film on glass deposited by the evaporation process; measured in vacuum (0.001 mm Hg).
4	125	1962	298	0.550-32	5°	5°	$\pm$ 0.1	99.998 pure; Al film (0.065 to 0.11 μ thick), evaporated at 1×10^{-5} mm Hg, supersmooth fused quartz optical flats as substrate, no watermarks or other blemishes on the substrate surface, no shadows or streaks in the evaporated Al film; freshly prepared; measured in dry nitrogen.
5	125	1962	298	0.550-32	5°	5°	$\pm$ 0.1	99.998 pure; Al film (0.065 to 0.11 μ thick), evaporated at 1×10^{-5} mm Hg, supersmooth fused quartz optical flats as substrate, no watermarks or other blemishes on the substrate surfaces, no shadows or streaks in the evaporated Al film; aged in air for several weeks; measured in dry nitrogen.
6	126	1953	300	1.00-15.00	5°	2π	$\pm$ 2.6	Foil (0.001 in. thick); data extracted from smooth curve; converted from β (2π, 5°).
7	126	1953	300	1.00-15.00	5°	2π	$\pm$ 2.6	Disc (0.032 in. thick); polished, roughened (roughness approximately 50 microinches); data extracted from smooth curve; converted from β (2π, 5°).
8	126	1953	300	1.00-15.00	5°	2π	$\pm$ 4.3	Disc; commercial finish; data extracted from smooth curve; converted from β (2π, 5°).
9	126	1953	300	1.00-15.00	5°	2π	$\pm$ 2.7	Disc; polished; data extracted from smooth curve; converted from β (2π, 5°).
10	127	1955	298	0.46-0.60	10°	2π	$\pm$ 0.5	99 pure; vacuum deposited on glass; measured immediately after removed from vacuum chamber; calculated by authors from $\rho = 1 - \alpha$ using an incandescent tungsten lamp as source.
11	127	1955	298	0.46-0.60	10°	2π	$\pm$ 0.5	Above specimen and conditions except exposed to the atmosphere for 8 days.
12	127	1955	298	0.46-0.60	10°	2π		99.99 pure; vacuum deposited on glass; measured immediately after removed from vacuum chamber; calculated by authors from $\rho = 1 - \alpha$ using an incandescent tungsten lamp as source.
13	127	1955	298	0.46-0.60	10°	2π		Above specimen and conditions except except exposed to atmosphere for 8 days.
14	128	1962	298	2.00-20.00	$\sim 0°$	2π		Evaporated Al on mylar substrate (0.20 μ thick); illumination solid angle is cone of 0.034 steradians; converted from β (2π, 0).
15	129	1964	298	0.20-0.70	$\sim 0°$	2π		Evaporated aluminum; data extracted from smooth curve.
16	130	1934	298	0.225-2.3	$\sim 0°$	$\sim 0°$		Deposited on a mirror by evaporation.
17	133	1934	298	0.235-0.578	$\sim 0°$	$\sim 0°$	2	Disc; cold worked, annealed, etch tested, polished, stored in a solution of NaOH + NaF, washed and dried.
18	220	1965	298	0.300-1.000	$\sim 0°$	2π		Sand blasted.
19	222	1960	298	0.450-0.600	$\sim 7°$	$\sim 7°$	< 0.16	Measured in air.
20	223	1962	298	2.01-25.96	$\sim 0°$	2π		Polished; converted from β (2π, 0°).

SPECIFICATION TABLE NO. 8 (continued)

Curve No.	Ref. No.	Year	Temperature K	Wavelength Range, μ	Geometry θ	θ'	ω'	Reported Error, %	Composition (weight percent), Specifications and Remarks
21	223	1962	298	1.57-25.94	~0°		2π		Above specimen and conditions except after particle impact.
22	223	1962	77	1.91-26.00	~0°		2π		Above specimen and conditions.
23	224	1931	298	0.2653-0.4038	~5°		2π		Acid-etched.
24	216	1949	~298	1.01-15.00	0°		2π	5	Foil; data extracted from smooth curve.
25	285	1962	298	1.97-13.05	~5°	~5°			
26	336	1964	298	2.00-23.99	~0°	~0°			Polished.
27	336	1964	298	2.00-23.99	~0°	~0°			Above specimen and conditions except cratered with spherical particles (100 μ dia) of Zircalloy at 1.5 km sec^{-1}; average crater dia 123 μ; average crater depth 289 μ; Knoop hardness 22 (100 g load).
28	336	1964	298	2.00-22.00	~0°	~0°			Different sample, same as above specimen and conditions except cratered with spherical particles (100 μ dia) of tungsten at 7 km sec^{-1}; average crater depth 54 μ; average crater depth 183 μ; Knoop hardness 22 (100 g load).
29	341	1967	298	0.079-0.1175	~0°	~0°			Evaporated film; 99.999 pure; evaporated on microscope slide at 3 x 10^{-8} mm Hg; measured in vacuum (3 x 10^{-8} mm Hg) 4 min after evaporation.
30	341	1967	298	0.079-0.1175	~0°	~0°			Different sample, same as above specimen and conditions except measured 8 min after evaporation.
31	341	1967	298	0.079-0.1175	~0°	~0°			Different sample, same as above specimen and conditions except measured 12 min after evaporation.
32	341	1967	298	0.079-0.1175	~0°	~0°			Different sample, same as above specimen and conditions except measured 16 min after evaporation.
33	344	1963	298	2.47-12.08	~5°	~5°			Aluminized ground glass; aluminum mirror reference; ω' = 0.03 Sr.
34	344	1963	298	0.52-12.07	~5°	~5°			Aluminized ground steel; aluminum mirror reference; ω' = 0.03 Sr.
35	344	1963	298	7.07-22.10	~5°	~5°			Aluminized ground glass; glass ground with M302 grinding powder (Al_2O_3 emery) with average particle size of 22 μ; aluminum mirror reference; ω' = 0.03 Sr.
36	344	1963	298	5.08-22.19	~5°	~5°			Aluminized ground glass; glass ground with W6 grinding powder ($Fe_3Al_2(SiO_4)_3$ garnet) with average particle size of 12 μ; aluminum mirror reference; ω' = 0.03 Sr.
37	344	1963	298	5.07-22.12	~5°	~5°			Aluminized ground glass; glass ground with M 303.5 grinding powder (Al_2O_3 emery) with average particle size of 11 μ; aluminum mirror reference; ω' = 0.03 Sr.
38	344	1963	298	0.63-22.11	~5°	~5°			Aluminized ground glass; glass ground with W10 grinding powder ($Fe_3Al_2(SiO_4)_3$ garnet) with average particle size of 5 μ; aluminum mirror reference; ω' = 0.03 Sr.
39	344	1963	298	0.64-22.14	~5°	~5°			Aluminized ground glass; glass ground with M 305 grinding powder (Al_2O_3 emery) with average particle size of 5 μ; aluminum mirror reference; ω' = 0.03 Sr.
40	344	1963	298	3.93-22.23	~5°	~5°			Aluminized dense flint; flint ground with M303.5 grinding powder (Al_2O_3 emery) with average particle size of 11 μ; aluminum mirror reference; ω' = 0.03 Sr.

SPECIFICATION TABLE NO. 8 (continued)

Curve No.	Ref. No.	Year	Temperature K	Wavelength Range, μ	Geometry θ	θ'	ω'	Reported Error, %	Composition (weight percent), Specifications and Remarks
41	344	1963	298	3.88-22.25	$\sim 5°$	$\sim 5°$			Aluminized plate glass; glass ground with M303.5 grinding powder (Al_2O_3 emery) with average particle size of 11 μ; aluminum mirror reference; ω' = 0.03 Sr.
42	344	1963	298	4.06-22.23	$\sim 5°$	$\sim 5°$			Aluminized Pyrex; Pyrex ground with M303.5 grinding powder (Al_2O_3 emery) with average particle size of 11 μ; aluminum mirror reference; ω' = 0.03 Sr.
43	344	1963	298	2.49-22.21	$\sim 5°$	$\sim 5°$			Aluminized fused quartz; quartz ground with M303.5 grinding powder (Al_2O_3 emery) with average particle size of 11 μ; aluminum mirror reference; ω' = 0.03 Sr.

DATA TABLE NO. 8 NORMAL SPECTRAL REFLECTANCE OF ALUMINUM

[Wavelength λ, μ; Reflectance ρ; Temperature T, K]

CURVE 1
T = 298

λ	ρ
0.30	0.430
0.33	0.435
0.40	0.408
0.60	0.355
0.84	0.305
1.00	0.325
1.50	0.311
2.10	0.300
2.50	0.300

CURVE 2
T = 298

λ	ρ
0.30	0.790
0.33	0.775
0.40	0.796
0.50	0.819
0.60	0.812
0.70	0.800
0.825	0.752
0.90	0.800
1.00	0.840
1.20	0.865
1.40	0.870
1.60	0.877
1.80	0.877
2.00	0.890
2.20	0.884
2.40	0.899
2.50	0.905

CURVE 3
T = 298

λ	ρ
0.1347	0.10
0.1438	0.14
0.1570	0.17
0.1640	0.20
0.1857	0.23
0.1901	0.29
0.2026	0.34

CURVE 4
T = 298

λ	ρ
0.550	0.9094
0.600	0.9048
0.650	0.8989
0.700	0.8900
0.750	0.8761
0.775	0.8678
0.800	0.8604
0.825	0.8569
0.850	0.8622
0.875	0.8759
0.900	0.8920
0.925	0.9072
0.950	0.9192
1.000	0.9360
1.200	0.9596
1.500	0.9676
2.000	0.9718
3.000	0.9765
4.000	0.9795
5	0.9812
6	0.9823
7	0.9831
8	0.9837
9	0.9841
10	0.9845
11	0.9849
12	0.9854
13	0.9857
14	0.9861
16	0.9868
18	0.9873
20	0.9878
22	0.9883
24	0.9887
26	0.9890
28	0.9893
30	0.9896
32	0.9898

CURVE 5*
T = 298

λ	ρ
0.550	0.9049
0.600	0.9021

CURVE 5 (cont.)*
T = 298

λ	ρ
0.650	0.8976
0.700	0.8886
0.750	0.8761
0.775	0.8678
0.800	0.8596
0.825	0.8556
0.850	0.8596
0.875	0.8730
0.900	0.8894
0.925	0.9030
0.950	0.9154
1.000	0.9224
1.200	0.9585
1.500	0.9658
2.000	0.9699
3.000	0.9736
4.000	0.9758
5	0.9772
6	0.9784
7	0.9794
8	0.9801
9	0.9807
10	0.9812
11	0.9816
12	0.9821
13	0.9826
14	0.9830
16	0.9838
18	0.9845
20	0.9852
22	0.9856
24	0.9861
26	0.9864
28	0.9867
30	0.9870
32	0.9872

CURVE 6
T = 300

λ	ρ
1.00	0.765
1.25	0.810
1.50	0.840
1.75	0.860

CURVE 6 (cont.)
T = 300

λ	ρ
2.00	0.885
2.25	0.878
2.50	0.895
2.75	0.900
3.00	0.910
3.25	0.910
3.50	0.923
3.75	0.925
4.00	0.935
4.25	0.941
4.50	0.925
4.75	0.948
5.00	0.940
5.25	0.939
5.50	0.940
5.75	0.948
6.00	0.950
6.25	0.960
6.50	0.948
6.75	0.950
7.25	0.950
7.50	0.945
7.75	0.949
8.00	0.945
8.25	0.942
8.50	0.951
9.25	0.949
10.00	0.960
10.50	0.940
10.75	0.955
11.00	0.949
11.25	0.960
11.50	0.951
11.75	0.960
12.50	0.960
12.75	0.965
13.00	0.960
13.25	0.950
13.75	0.950
14.00	0.935
14.25	0.955
14.75	0.936
15.00	0.925

CURVE 7
T = 300

λ	ρ
1.00	0.579
1.25	0.618
1.50	0.670
1.75	0.685
2.00	0.715
2.50	0.740
2.75	0.745
3.00	0.725
3.25	0.740
3.50	0.772
3.75	0.780
4.00	0.788
4.25	0.780
4.50	0.793
4.75	0.800
5.00	0.800
5.25	0.802
5.50	0.805
5.75	0.809
6.00	0.800
6.25	0.805
7.00	0.805
7.75	0.821
8.00	0.819
8.25	0.821
8.50	0.820
8.75	0.819
9.00	0.819
9.25	0.821
9.50	0.818
9.75	0.819
10.00	0.820
10.25	0.831
10.50	0.831
10.75	0.839
11.00	0.831
11.25	0.841
11.50	0.841
11.75	0.840
12.00	0.848
12.25	0.845
12.50	0.849
12.75	0.845
13.25	0.846
13.50	0.842

CURVE 7 (cont.)
T = 300

λ	ρ
13.75	0.848
14.00	0.840
14.25	0.841
14.50	0.843
14.75	0.855
15.00	0.840

CURVE 8
T = 300

λ	ρ
1.00	0.470
1.25	0.530
1.50	0.569
1.75	0.601
2.00	0.630
2.25	0.655
2.50	0.670
2.75	0.700
3.00	0.710
3.25	0.725
3.50	0.735
3.75	0.760
4.00	0.765
4.25	0.792
4.50	0.782
4.75	0.805
5.00	0.810
5.25	0.813
5.50	0.830
5.75	0.820
6.00	0.820
6.25	0.855
6.50	0.849
6.75	0.860
7.00	0.860
7.25	0.850
7.50	0.879
7.75	0.862
8.00	0.870
8.25	0.889
8.50	0.891
8.75	0.888
9.00	0.899
9.50	0.885
9.75	0.898

CURVE 8 (cont.)
T = 300

λ	ρ
10.00	0.890
10.25	0.898
10.50	0.920
10.75	0.898
11.00	0.900
11.25	0.912
11.50	0.913
11.75	0.910
12.00	0.892
12.25	0.960
12.50	0.892
12.75	0.922
13.00	0.915
13.25	0.899
13.50	0.915
13.75	0.919
14.00	0.915
14.25	0.900
14.50	0.895
14.75	0.891
15.00	0.915

CURVE 9
T = 300

λ	ρ
1.00	0.731
1.25	0.788
1.50	0.840
1.75	0.845
2.00	0.855
2.25	0.881
2.50	0.860
2.75	0.860
3.00	0.875
3.25	0.879
3.50	0.891
3.75	0.898
4.00	0.915
4.25	0.890
4.50	0.931
4.75	0.910
5.00	0.960
5.25	0.915
5.50	0.940
5.75	0.925

*Not shown on plot

DATA TABLE NO. 8 (continued)

CURVE 9 (cont.)
T = 300

λ	ρ
6.00	0.936
6.50	0.930
6.75	0.932
7.00	0.942
7.25	0.935
8.00	0.960
8.25	0.990
8.75	0.935
9.00	0.960
9.25	0.960
9.50	0.955
9.75	0.969
10.00	0.969
10.50	0.975
10.75	0.970
11.00	0.972
11.25	0.972
11.50	0.959
11.75	0.972
12.00	0.960
12.25	0.960
12.50	0.963
12.75	0.959
13.00	0.980
13.25	0.969
13.50	0.964
13.75	0.960
14.00	0.965
14.25	0.951
14.50	0.969
14.75	0.965
15.00	0.972

CURVE 10
T = 298

λ	ρ
0.46	0.89
0.53	0.89
0.57	0.90
0.60	0.90

CURVE 11
T = 298

λ	ρ
0.46	0.86
0.53	0.86
0.57	0.85
0.60	0.86

CURVE 12
T = 298

λ	ρ
0.46	0.92
0.53	0.92
0.57	0.93
0.60	0.93

CURVE 13
T = 298

λ	ρ
0.46	0.895
0.53	0.895
0.57	0.885
0.60	0.880

CURVE 14
T = 298

λ	ρ
2.00	0.970
10.00	0.970*
20.00	0.975

CURVE 15
T = 298

λ	ρ
0.20	0.90
0.30	0.92
0.50	0.92
0.70	0.89

CURVE 16
T = 298

λ	ρ
0.225	0.79
0.250	0.80
0.275	0.81
0.300	0.83
0.325	0.84
0.350	0.85
0.375	0.86
0.400	0.86
0.450	0.87
0.500	0.88
0.600	0.89
0.70	0.87
0.75	0.88
0.8	0.85
0.85	0.87
0.9	0.88
0.95	0.94

CURVE 16 (cont.)
T = 298

λ	ρ
1.00	0.93
1.25	0.96
1.6	0.98
1.8	0.97
2.2	0.96
2.3	1.00

CURVE 17
T = 298

λ	ρ
0.235	0.413
0.254	0.482
0.265	0.523
0.293	0.662
0.312	0.679
0.334	0.722
0.366	0.740
0.406	0.712
0.435	0.759
0.546	0.780
0.578	0.781

CURVE 18
T = 298

λ	ρ
0.300	0.671
0.357	0.706
0.419	0.733
0.488	0.753
0.538	0.756
0.579	0.754
0.627	0.751
0.752	0.751
0.871	0.747
1.000	0.738

CURVE 19*
T = 298

λ	ρ
0.450	0.9083
0.500	0.9082
0.550	0.9064
0.600	0.9026

CURVE 20
T = 298

λ	ρ
2.01	0.960
5.27	0.973
7.94	0.979
11.36	0.981
14.07	0.982
19.27	0.982
25.96	0.984

CURVE 21*
T = 298

λ	ρ
1.57	0.890
4.34	0.929
7.17	0.946
8.53	0.946
11.73	0.953
14.46	0.954
17.38	0.961
19.33	0.961
22.54	0.957
25.94	0.952

CURVE 22*
T = 77

λ	ρ
1.91	0.908
3.95	0.939
5.94	0.937
7.90	0.945
9.94	0.955
11.97	0.952
13.88	0.953
15.89	0.959
17.92	0.962
19.94	0.960
21.86	0.957
23.93	0.949
26.00	0.949

CURVE 23
T = 298

λ	ρ
0.2653	0.756
0.2890	0.796
0.3133	0.822
0.3664	0.839
0.4038	0.849

CURVE 24*
T = ~298

λ	ρ
1.01	0.929
1.26	0.928
1.50	0.944
1.79	0.949
1.98	0.955
2.25	0.957
2.50	0.959
2.75	0.955
2.98	0.956
3.27	0.964
3.50	0.955
3.75	0.963
3.96	0.974
4.24	0.940
4.48	0.968
4.76	0.969
4.98	0.969
5.24	0.972
5.50	0.969
5.73	0.965
5.98	0.977
6.26	0.975
6.49	0.975
6.74	0.971
6.98	0.969
7.26	0.969
7.51	0.970
7.76	0.976
7.98	0.974
8.26	0.974
8.53	0.978
8.78	0.968
9.00	0.967
9.29	0.972
9.55	0.971
9.79	0.974
10.01	0.973
10.27	0.973
10.53	0.973
10.77	0.973
11.04	0.973
11.30	0.974
11.52	0.976
11.78	0.976
12.02	0.976
12.27	0.977
12.51	0.974
12.79	0.976

CURVE 24 (cont.)*
T = ~298

λ	ρ
13.01	0.976
13.28	0.976
13.50	0.977
13.79	0.976
14.01	0.976
14.28	0.977
14.53	0.973
14.75	0.966
15.00	0.971

CURVE 25*
T = 298

λ	ρ
1.97	0.9670
2.97	0.9712
3.95	0.9747
4.98	0.9765
6.00	0.9774
7.03	0.9778
8.03	0.9783
9.00	0.9790
10.00	0.9791
11.09	0.9796
12.04	0.9798
13.05	0.9805

CURVE 26*
T = 298

λ	ρ
2.00	0.964
4.00	0.970
5.99	0.973
8.00	0.977
10.00	0.980
12.00	0.981
14.00	0.980
16.00	0.980
18.00	0.980
20.00	0.979
22.00	0.979
23.99	0.978

CURVE 27*
T = 298

λ	ρ
2.00	0.897
4.00	0.918
5.99	0.933
8.00	0.945
10.00	0.954
12.00	0.952
14.00	0.954
16.00	0.958
18.00	0.958
20.00	0.955
22.00	0.946
23.99	0.946

CURVE 28
T = 298

λ	ρ
2.00	0.566
4.00	0.676
5.99	0.731
8.00	0.741
10.00	0.757
12.00	0.777
14.00	0.786
16.00	0.789
18.00	0.790
20.00	0.792
22.00	0.792

CURVE 29*
T = 298

λ	ρ
0.0790	0.325
0.0833	0.624
0.0920	0.767
0.1175	0.815

CURVE 30*
T = 298

λ	ρ
0.0790	0.308
0.0833	0.588
0.0920	0.728
0.1175	0.811

*Not shown on plot

CURVE 31*
T = 298

λ	ρ
0.0790	0.292
0.0833	0.559
0.0920	0.689
0.1175	0.811

CURVE 32*
T = 298

λ	ρ
0.0790	0.276
0.0833	0.528
0.0920	0.653
0.1175	0.811*

CURVE 33
T = 298

λ	ρ
2.47	0.033
2.99	0.082
3.97	0.230
4.98	0.386
6.00	0.515
7.00	0.615
8.02	0.692
9.00	0.760
10.04	0.797
11.04	0.831*
12.08	0.857

CURVE 34
T = 298

λ	ρ
0.52	0.065
0.71	0.063
0.89	0.060
1.47	0.075
2.00	0.093
2.99	0.163
3.99	0.270
4.99	0.398
6.00	0.513
7.00	0.612
8.01	0.688
9.02	0.746
10.03	0.784
11.06	0.822
12.07	0.849

CURVE 35
T = 298

λ	ρ
7.07	0.083
8.04	0.140
9.06	0.206
10.04	0.272
11.04	0.337
12.01	0.409
13.00	0.456
14.06	0.509
15.25	0.565
16.07	0.597
17.07	0.634
18.05	0.668
19.07	0.694
20.12	0.728
21.12	0.755
22.10	0.788

CURVE 36
T = 298

λ	ρ
5.08	0.079
6.07	0.161
7.08	0.250
8.06	0.339
9.03	0.428
10.08	0.492
11.04	0.559
12.08	0.617
13.06	0.656
14.10	0.699
15.34	0.738
16.12	0.759
17.03	0.782
18.04	0.802
19.07	0.823
20.13	0.846
21.16	0.864
22.19	0.883

CURVE 37
T = 298

λ	ρ
5.07	0.108
6.02	0.197
7.05	0.294
8.05	0.384

CURVE 37 (cont.)

λ	ρ
9.06	0.474
10.03	0.537
11.07	0.602
12.08	0.660
13.08	0.703
14.07	0.738
15.26	0.777
16.12	0.803
17.10	0.820
18.10	0.840
19.10	0.859
20.13	0.877
21.14	0.891
22.12	0.902

CURVE 38
T = 298

λ	ρ
0.63	0.025
0.87	0.079
0.99	0.126
1.08	0.168
1.49	0.277
2.09	0.398
3.06	0.548
4.06	0.661
5.07	0.738
6.07	0.801*
7.04	0.841
8.06	0.873
9.10	0.896
10.01	0.911
11.06	0.926
12.06	0.939
13.12	0.953
14.12	0.958
15.08	0.963
16.10	0.969
17.08	0.972
18.09	0.974
19.13	0.978
20.18	0.981
21.12	0.981
22.11	0.989

CURVE 39*
T = 298

λ	ρ
0.64	0.027
0.77	0.077
0.97	0.126
1.07	0.172
1.56	0.412
2.08	0.575
3.11	0.752
4.08	0.845
5.07	0.892
6.05	0.919
7.10	0.942
8.10	0.956
9.09	0.965
10.09	0.970
11.08	0.974
12.09	0.980
13.11	0.983
14.12	0.986
15.08	0.989
16.15	0.993
17.13	0.993
18.13	0.993
19.11	0.994
20.16	0.994
21.15	0.994
22.14	0.998

CURVE 40*
T = 298

λ	ρ
3.93	0.005
5.05	0.095
6.03	0.190
7.01	0.284
8.02	0.373
9.02	0.452
10.03	0.524
11.02	0.588
12.09	0.649
13.10	0.684
14.10	0.722
15.28	0.762
16.15	0.783
17.11	0.806
18.17	0.829
19.20	0.845

CURVE 40 (cont.)*

λ	ρ
20.23	0.862
21.23	0.876
22.23	0.892

CURVE 41*
T = 298

λ	ρ
3.88	0.014
5.03	0.107
6.01	0.197
7.01	0.292
8.03	0.380
9.03	0.467
10.03	0.531
11.07	0.597
12.12	0.655
13.07	0.694
14.12	0.733
15.30	0.769
16.13	0.795
17.12	0.814
18.16	0.832
19.17	0.853
20.20	0.872
21.25	0.886
22.25	0.898

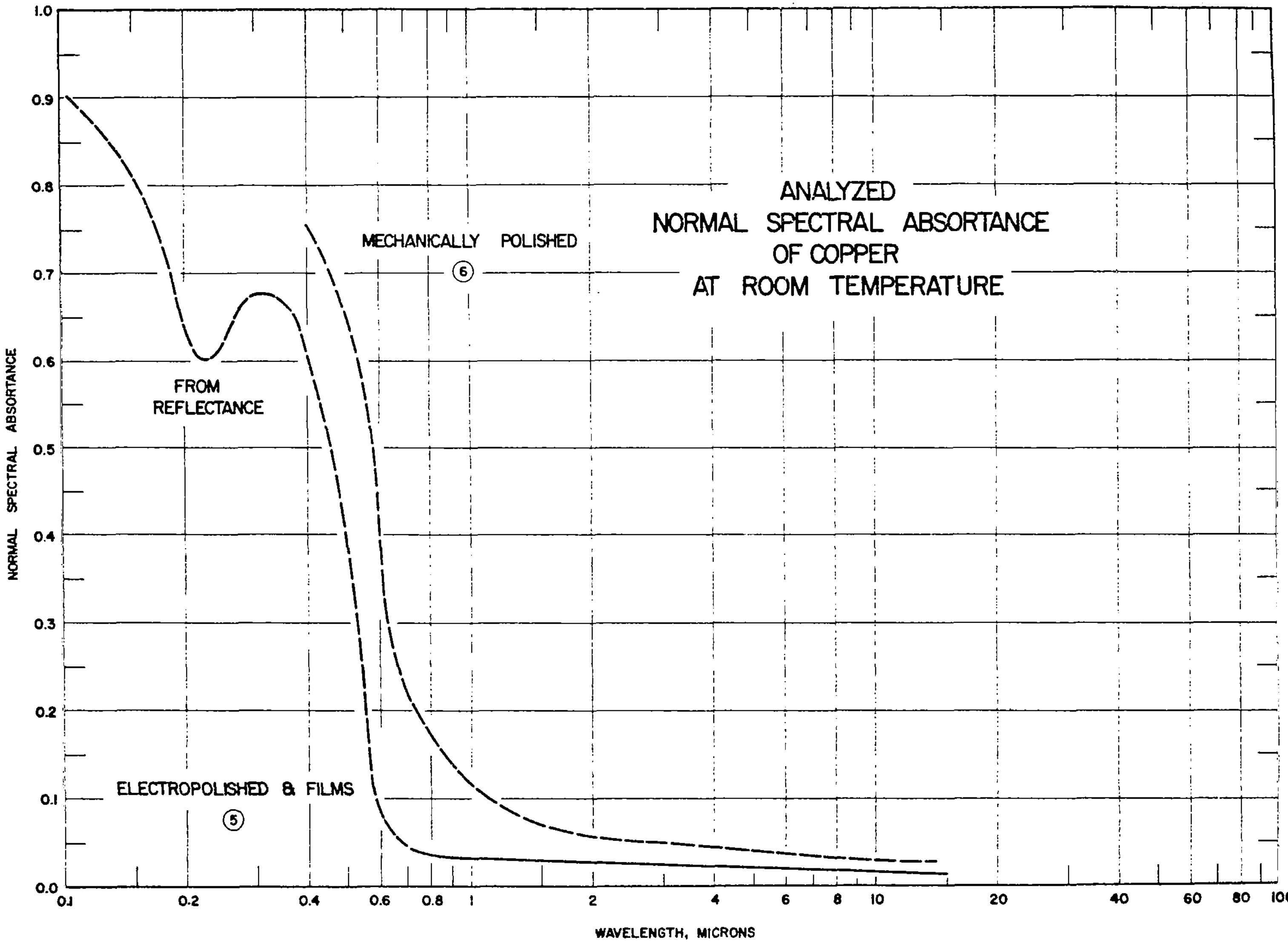
CURVE 42
T = 298

λ	ρ
4.06	0.119
5.03	0.243
6.05	0.372
7.05	0.479
8.02	0.564
9.07	0.646
10.05	0.694
11.10	0.738
12.09	0.781
13.08	0.807
14.14	0.833
15.32	0.856
16.13	0.867
17.17	0.883
18.24	0.897
19.16	0.908
20.22	0.918
21.22	0.927
22.23	0.939

CURVE 43
T = 298

λ	ρ
2.49	0.033
3.09	0.077
4.07	0.225
5.06	0.382
6.08	0.509
7.08	0.611
8.07	0.683
9.13	0.753
10.11	0.789
11.09	0.824
12.10	0.855
13.07	0.874
14.10	0.890
15.35	0.910
16.16	0.918
17.13	0.930
18.18	0.939
19.17	0.946
20.25	0.952
21.23	0.960
22.21	0.967

*Not shown on plot


ANALYZED
NORMAL SPECTRAL ABSORTANCE
OF COPPER
AT ROOM TEMPERATURE
MECHANICALLY POLISHED
6
FROM
REFLECTANCE
ELECTROPOLISHED & FILMS
5
NORMAL SPECTRAL ABSORTANCE
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.1
0.2
0.4
0.6
0.8
1
2
4
6
8
10
20
40
60
80
100
WAVELENGTH, MICRONS

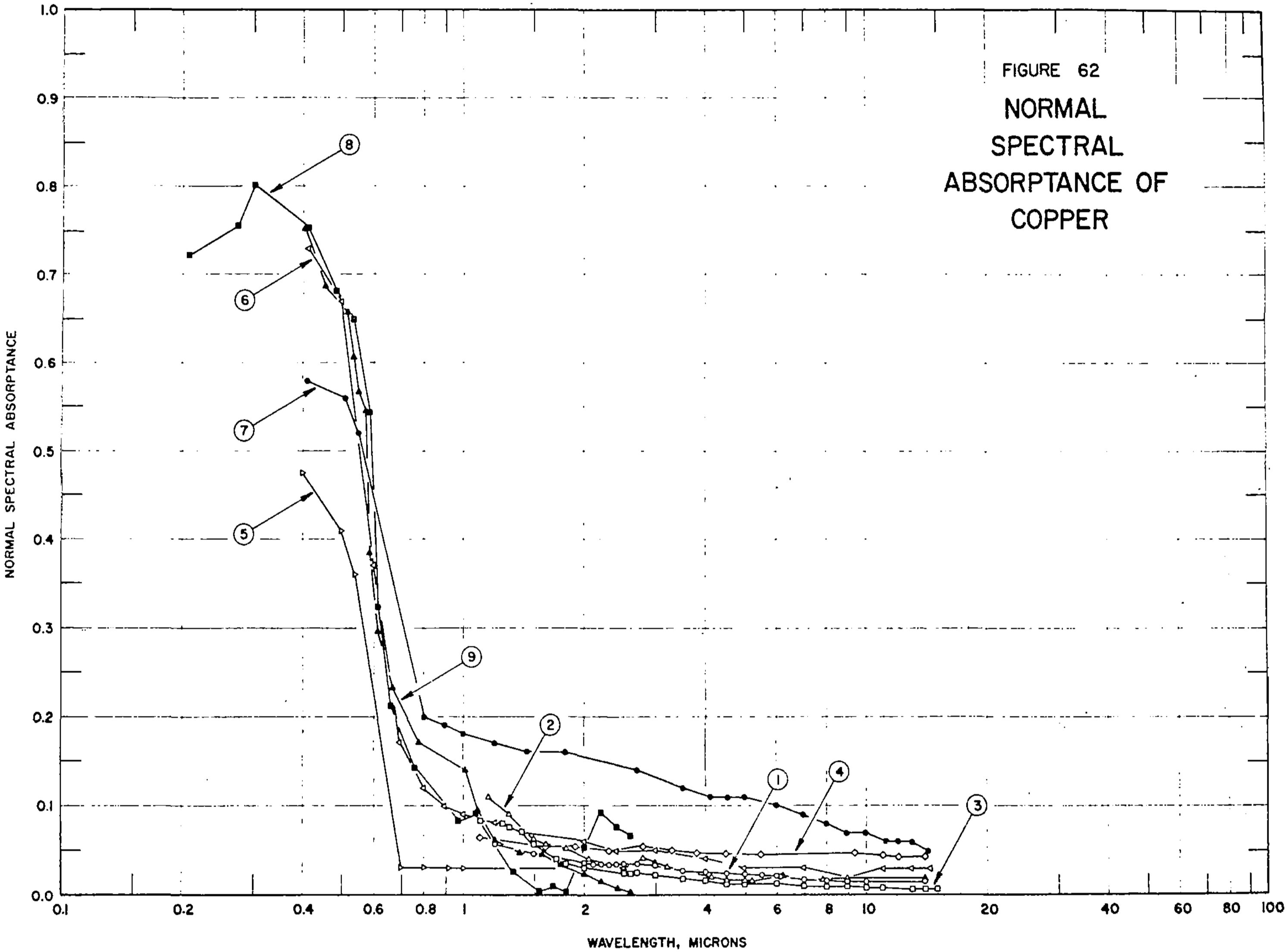


FIGURE 62
NORMAL SPECTRAL ABSORPTANCE OF COPPER

SPECIFICATION TABLE NO. 62 NORMAL SPECTRAL ABSORPTANCE OF COPPER

Curve No.	Ref. No.	Year	Temperature K	Wavelength Range, μ	Geometry θ	Reported Error, %	Composition (weight percent), Specifications and Remarks
1	30	1963	294	1.20-14.00	~0°		Mechanically polished (surface roughness 0.02μ peak to peak and 5μ lateral); measured in air; data extracted from smooth curve; [Author's designation: Sample 3].
2	30	1963	294	1.15-14.00	~0°		Above specimen and conditions except heated at 450 K for 3 hrs; surface oxidation possible.
3	30	1963	294	1.10-15.00	~0°		Above specimen and conditions except heated at 922 K for 3 hrs.
4	30	1963	294	1.10-14.00	~0°		Above specimen and conditions except heated at 1222 K for 102 hrs.
5	65	1962	294	0.40-2.00	~0°		Electropolished; calculated from (1- ρ).
6	65	1962	294	0.41-14.40	~0°		Mechanically polished; calculated from (1 - ρ).
7	65	1962	294	0.41-14.20	~0°		Above specimen and conditions except roughened with sand paper; surface roughness 1.25μ.
8	307	1954	~298	0.207-2.600	~0°		Data extracted from smooth curve.
9	307	1954	~298	0.401-2.600	~0°		Polished; data extracted from smooth curve.

DATA TABLE NO. 62 NORMAL SPECTRAL ABSORPTANCE OF COPPER

[Wavelength, λ, μ; Absorptance, α; Temperature, T, K]

CURVE 1
T = 294

λ	α
1.20	0.057
1.50	0.046
2.00	0.036
2.10	0.034
2.20	0.034
2.30	0.033
2.40	0.034
2.50	0.035
2.70	0.035
3.00	0.033
3.50	0.028
4.00	0.027
4.50	0.025
5.00	0.023
5.50	0.022
6.00	0.021
6.10	0.021
7.00	0.018
8.00	0.017
9.00	0.015
10.00	0.015
14.00	0.015

CURVE 2
T = 294

λ	α
1.15	0.110
1.30	0.090
1.50	0.062
1.60	0.057
1.80	0.051
2.05	0.040
2.30	0.032*
2.50	0.031
2.80	0.041
3.00	0.035
3.20	0.031
3.50	0.028*
4.10	0.020
4.50	0.017
5.00	0.016
5.20	0.016
6.00	0.020*

CURVE 2 (cont.)

λ	α
6.20	0.021
7.00	0.019*
7.80	0.018
9.00	0.018
14.00	0.019

CURVE 3
T = 294

λ	α
1.10	0.082
1.25	0.080
1.30	0.076
1.40	0.070
1.50	0.057
1.70	0.040
1.80	0.035
2.00	0.031
2.50	0.024
2.60	0.024
2.70	0.025
3.00	0.022
3.50	0.019
4.00	0.016
4.50	0.013
5.00	0.012
6.00	0.012
7.00	0.011
8.00	0.010
9.00	0.009
10.00	0.008
11.00	0.008
13.00	0.007
14.00	0.007
15.00	0.007

CURVE 4
T = 294

λ	α
1.10	0.064
1.50	0.055*
1.60	0.054
1.90	0.054
2.30	0.050
2.80	0.055

CURVE 4 (cont.)

λ	α
3.30	0.050
3.80	0.048
4.50	0.047
5.50	0.046
9.40	0.048
11.00	0.044
12.00	0.043
14.00	0.043

CURVE 5
T = 294

λ	α
0.40	0.475
0.50	0.410
0.54	0.360
0.70	0.031
0.80	0.031
0.92	0.031
1.00	0.030
2.00	0.031*

CURVE 6
T = 294

λ	α
0.41	0.73
0.50	0.67
0.60	0.37
0.70	0.17
0.80	0.12
0.90	0.10
1.00	0.09
1.20	0.08
1.40	0.07*
2.00	0.06
2.40	0.05
3.00	0.05
4.00	0.04
5.00	0.03
7.00	0.03
9.00	0.02*
11.00	0.03
13.00	0.03
14.40	0.03

CURVE 7
T = 294

λ	α
0.41	0.58
0.51	0.56
0.55	0.52
0.80	0.20
0.90	0.19
1.00	0.18
1.20	0.17
1.44	0.16
1.80	0.16
2.70	0.14
3.50	0.12
4.05	0.11
4.55	0.11
5.00	0.11
6.00	0.10
7.00	0.09
8.00	0.08
9.00	0.07
10.00	0.07
11.20	0.06
12.00	0.06
13.00	0.06
14.20	0.05

CURVE 8
T = ~298

λ	α
0.207	0.724
0.275	0.755
0.301	0.802
0.415	0.752
0.484	0.681
0.535	0.649
0.583	0.542
0.615	0.324
0.660	0.212
0.759	0.141
0.971	0.083
1.075	0.090
1.340	0.026
1.555	0.004
1.688	0.010
1.801	0.003

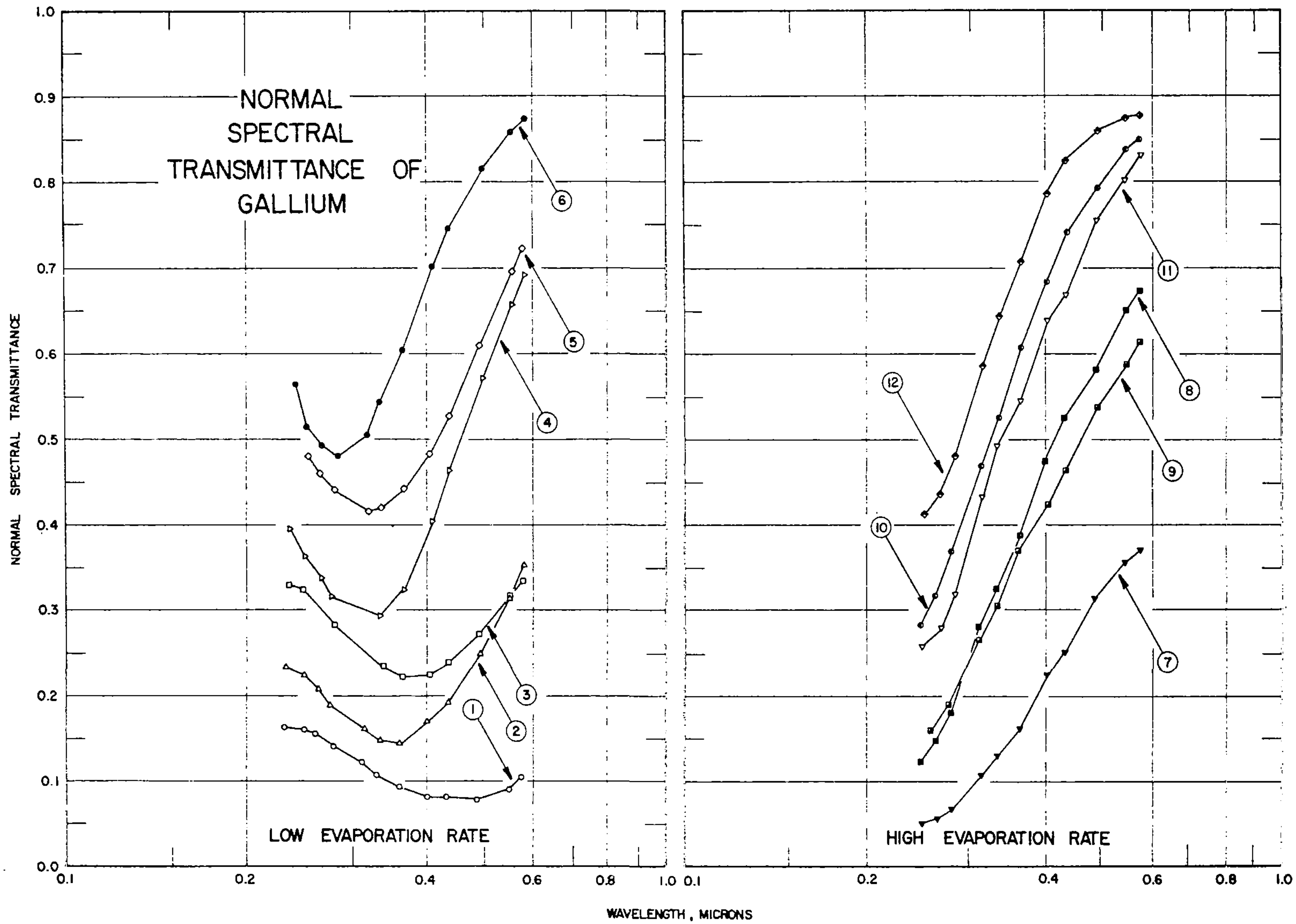
CURVE 8 (cont.)

λ	α
2.000	0.053
2.200	0.091
2.400	0.075
2.600	0.067

CURVE 9
T = ~298

λ	α
0.401	0.751
0.457	0.686
0.515	0.658
0.539	0.607
0.549	0.567
0.579	0.544
0.583	0.389
0.612	0.296
0.664	0.231
0.779	0.170
1.001	0.104
1.096	0.095
1.200	0.060
1.394	0.048
1.594	0.047
1.798	0.034
2.000	0.023
2.200	0.014
2.400	0.008
2.600	0.023

* Not shown on plot


NORMAL SPECTRAL TRANSMITTANCE OF GALLIUM
NORMAL SPECTRAL TRANSMITTANCE
WAVELENGTH, MICRONS
LOW EVAPORATION RATE
HIGH EVAPORATION RATE
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.1
0.2
0.4
0.6
0.8
1.0
1
2
3
4
5
6
7
8
9
10
11
12

SPECIFICATION TABLE NO. 73 NORMAL SPECTRAL TRANSMITTANCE OF GALLIUM

Curve No.	Ref. No.	Year	Temperature K	Wavelength Range, μ	Geometry θ	θ'	ω'	Reported Error, %	Composition (weight percent), Specifications and Remarks
1	229	1963	298	0.231-0.574	~0°	~0°			Vacuum deposited thin film of gallium (19 mμ thick); measured in vacuum; spectral Philips Zn, Cd and Hg Lamp sources; 3.5 Å min^{-1} evaporation rate.
2	229	1963	298	0.233-0.579	~0°	~0°			Different sample, same as above specimen and conditions except 11 mμ thick; 2 Å min^{-1} evaporation rate.
3	229	1963	298	0.236-0.578	~0°	~0°			Different sample, same as above specimen and conditions except 9.5 mμ thick.
4	229	1963	298	0.236-0.581	~0°	~0°			Different sample, same as above specimen and conditions except 5 mμ thick; 2 Å min^{-1} evaporation rate.
5	229	1963	298	0.242-0.577	~0°	~0°			Different sample, same as above specimen and conditions except 4.5 mμ thick.
6	229	1963	298	0.242-0.584	~0°	~0°			Different sample, same as above specimen and conditions except 2.5 mμ thick; 2 Å min^{-1} evaporation rate.
7	229	1963	298	0.250-0.579	~0°	~0°			Different sample, same as above specimen and conditions except 42 mμ thick; 300 Å min^{-1} evaporation rate; supercooled liquid suspected in the evaporated film.
8	229	1963	298	0.248-0.578	~0°	~0°			Different sample, same as curve 7 specimen and conditions except 28 mμ thick; 11 Å min^{-1} evaporation rate.
9	229	1963	298	0.258-0.579	~0°	~0°			Different sample, same as curve 7 specimen and conditions except 21 mμ thick.
10	229	1963	298	0.247-0.579	~0°	~0°			Different sample, same as curve 7 specimen and conditions except 14 mμ thick; 11 Å min^{-1} evaporation rate.
11	229	1963	298	0.249-0.581	~0°	~0°			Different sample, same as curve 7 specimen and conditions except 10 mμ thick.
12	229	1963	298	0.252-0.581	~0°	~0°			Different sample, same as curve 7 specimen and conditions except 7 mμ thick; 11 Å min^{-1} evaporation rate.

DATA TABLE NO. 73 NORMAL SPECTRAL TRANSMITTANCE OF GALLIUM

[Temperature, T, K; Transmittance, τ; Wavelength, λ, μ]

CURVE 1
T = 298

λ	τ
0.231	0.162
0.249	0.160
0.261	0.155
0.278	0.140
0.311	0.122
0.329	0.107
0.359	0.094
0.401	0.081
0.430	0.081
0.484	0.078
0.547	0.091
0.574	0.105

CURVE 2
T = 298

λ	τ
0.233	0.233
0.250	0.224
0.263	0.207
0.276	0.189
0.314	0.161
0.333	0.148
0.360	0.144
0.402	0.170
0.434	0.193
0.490	0.250
0.549	0.313
0.579	0.352

CURVE 3
T = 298

λ	τ
0.236	0.330
0.248	0.324
0.280	0.282
0.337	0.234
0.364	0.222
0.405	0.225
0.433	0.239
0.489	0.272
0.549	0.316
0.578	0.335

CURVE 4
T = 298

λ	τ
0.236	0.396
0.250	0.362
0.267	0.338
0.277	0.317
0.333	0.294
0.365	0.324
0.408	0.404
0.435	0.463
0.495	0.572
0.551	0.658
0.581	0.693

CURVE 5
T = 298

λ	τ
0.242	0.504
0.253	0.481
0.265	0.459
0.279	0.441
0.319	0.414
0.336	0.420
0.366	0.442
0.404	0.483
0.436	0.527
0.490	0.610
0.557	0.697
0.577	0.722

CURVE 6
T = 298

λ	τ
0.242	0.564
0.253	0.515
0.267	0.493
0.284	0.481
0.318	0.505
0.334	0.544
0.364	0.604
0.409	0.701
0.435	0.747
0.497	0.818
0.554	0.860
0.584	0.875

CURVE 7
T = 298

λ	τ
0.250	0.050
0.265	0.057
0.280	0.068
0.313	0.107
0.333	0.130
0.364	0.161
0.405	0.224
0.432	0.251
0.487	0.314
0.548	0.356
0.579	0.370

CURVE 8
T = 298

λ	τ
0.248	0.122
0.262	0.147
0.279	0.180
0.311	0.280
0.332	0.325
0.364	0.388
0.402	0.473
0.433	0.529
0.490	0.582
0.549	0.651
0.578	0.673

CURVE 9
T = 298

λ	τ
0.258	0.158
0.275	0.190
0.311	0.264
0.333	0.303
0.362	0.370
0.406	0.424
0.434	0.462
0.491	0.538
0.550	0.589
0.579	0.614

CURVE 10
T = 298

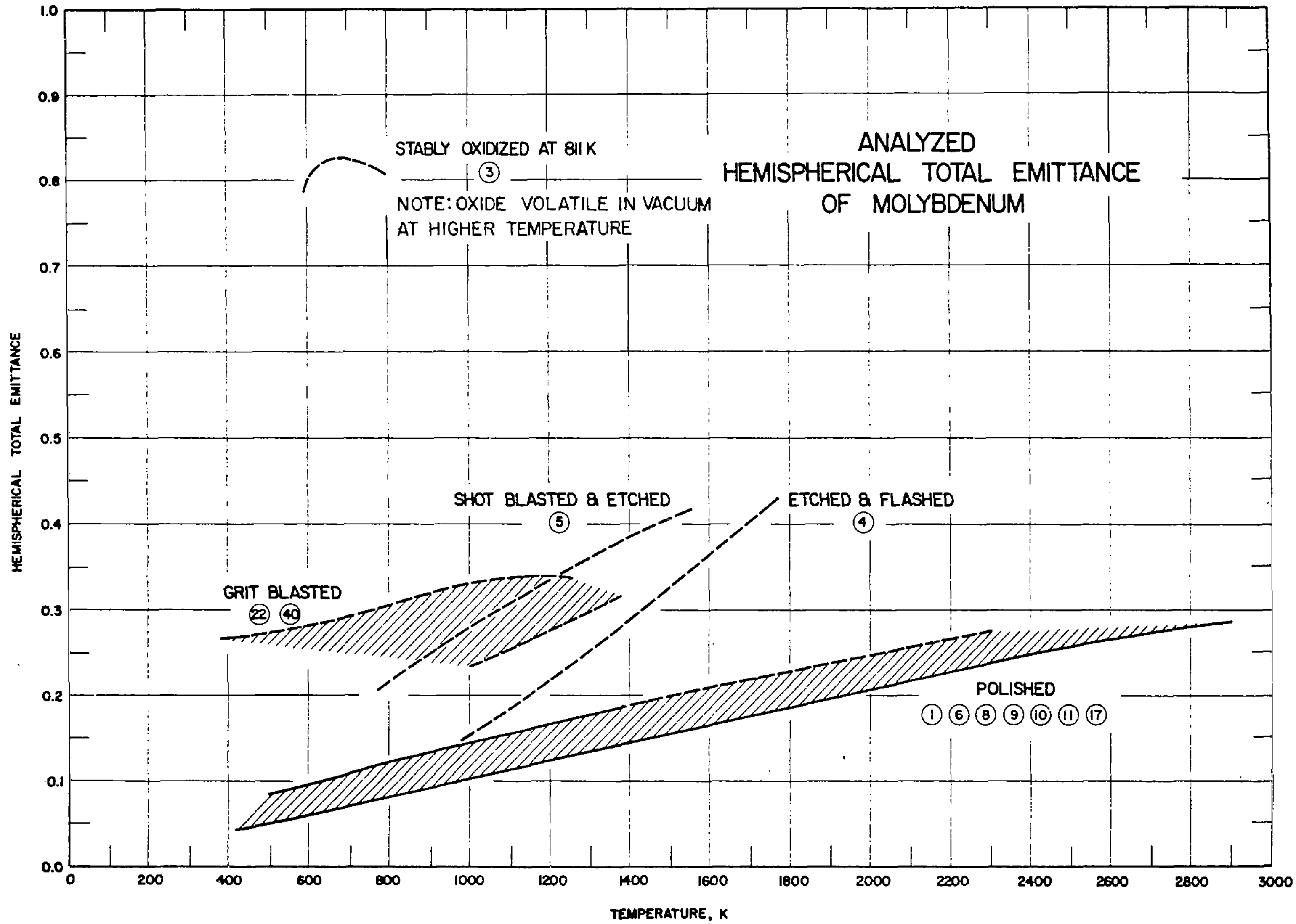
λ	τ
0.247	0.282
0.262	0.318
0.278	0.369
0.314	0.468
0.336	0.525
0.367	0.607
0.405	0.684
0.438	0.741
0.494	0.794
0.550	0.838
0.579	0.851

CURVE 11
T = 298

λ	τ
0.249	0.257
0.268	0.279
0.283	0.318
0.315	0.432
0.334	0.492
0.365	0.544
0.406	0.639
0.436	0.679
0.493	0.755
0.549	0.802
0.581	0.833

CURVE 12
T = 298

λ	τ
0.252	0.412
0.268	0.437
0.284	0.482
0.317	0.587
0.336	0.644
0.366	0.708
0.407	0.787
0.436	0.825
0.496	0.860
0.551	0.875
0.581	0.879


ANALYZED
HEMISPHERICAL TOTAL EMITTANCE
OF MOLYBDENUM
STABLY OXIDIZED AT 811 K
3
NOTE: OXIDE VOLATILE IN VACUUM
AT HIGHER TEMPERATURE
SHOT BLASTED & ETCHED
5
ETCHED & FLASHED
4
GRIT BLASTED
22 40
POLISHED
1 6 8 9 10 11 17
HEMISPHERICAL TOTAL EMITTANCE
TEMPERATURE, K
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000

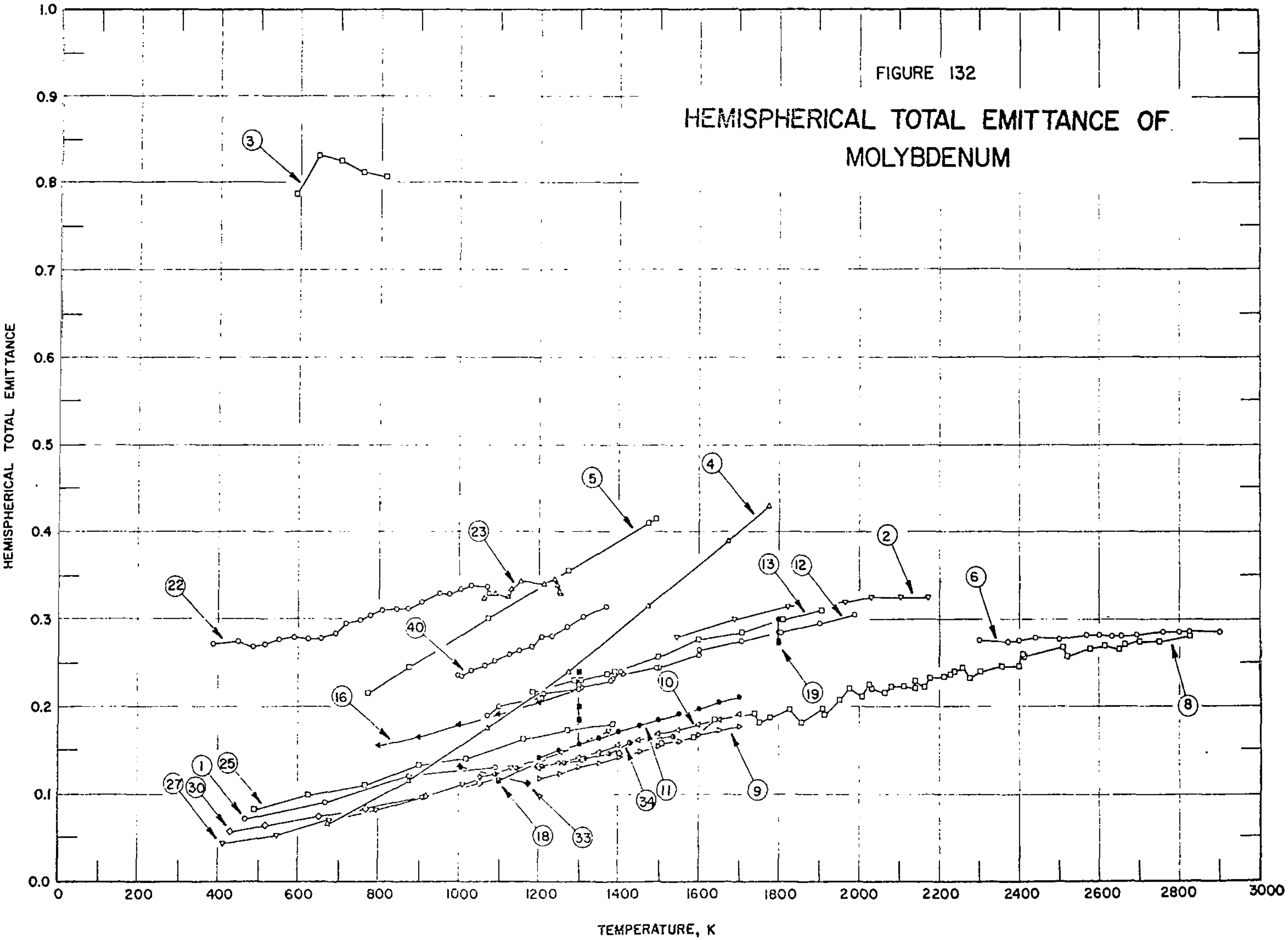


FIGURE 132

HEMISPHERICAL TOTAL EMITTANCE OF MOLYBDENUM

Curve No.	Ref. No.	Year	Temperature Range, K	Reported Error, %	Composition (weight percent), Specifications and Remarks
1	47	1961	468-1093	<10	Vacuum arc cast, machined, extruded, recrystallized, rolled; disc (0.04 in. thick); ground with 600 grit carborundum and polished on a wet cloth lap with unlevigated jewelers rouge; measured in vacuum (10^{-5} mm Hg).
2	69	1960	1544-2172	±10	Measured in vacuum.
3	22	1958	589-811	≤ 2	Stably oxidized at 811 K in quiescent air.
4	58	1961	673-1773	± 2.5	Lightly etched and flashed in vacuum at 2073 K for 10 min; measured in vacuum (<5 x 10^{-6} mm Hg); data extracted from smooth curve.
5	58	1961	773-1493	± 2.5	Shot-blasted and pickled in hydrochloric acid to remove iron; measured in vacuum (<5 x 10^{-6} mm Hg); data extracted from smooth curve.
6	70	1960	2300-2900		0.18 Fe, 0.073 Si, 0.04 C, 0.036 Mn, 0.005 O_2, 0.01 others, Mo balance; cast under inert gas; hot rolled; successively polished with No. 1-, 0-, 00-, 000-, and 0000- abrasive papers; measured in argon.
7	71	1962	1540-2180	±10	Measured in vacuum (<10^{-5} mm Hg).
8	72	1963	1506-2825		0.07-0.09 Fe, 0.04-0.06 Nb, 0.001-0.003 Mn, 0.001-0.003 Si, 0.0004-0.0006 Cu, 0.0001-0.0005 Mg, Mo balance; thin walled tube; polished using felt with a GOI paste; annealed; measured in vacuum.
9	73	1964	1200-1700	< 2.3	99.96 Mo, 0.004 SiO_2, 0.004 CaO and MgO, 0.026 sesquioxides; prepared by rubbing with abrasive paper; surface roughness 0.063-0.050 μ RMS; measured in vacuum (10^{-3} to 10^{-4} mm Hg); [Author's designation: Specimen 1].
10	73	1964	1200-1700	< 2.3	Different sample, same as curve 9 specimen and conditions; [Author's designation: Specimen 2].
11	73	1964	1200-1700	< 2.3	Different sample, same as curve 9 specimen; same conditions except surface roughness 1.25-1.00 μ RMS; [Author's designation: Specimen 3].
12	54	1962	1070-1990	± 4	Degreased with acetone, cleaned with a rubber eraser, wiped with acetone; measured in vacuum (10^{-4} to 10^{-6} mm Hg); same data reported for both samples; [Author's designation: Sample No. 1 and Sample No. 2].
13	54	1962	1185-1905	± 4	Degreased with acetone, cleaned with a rubber eraser, wiped with acetone; aged for 1 hr at 1773 K; measured in vacuum (10^{-4} to 10^{-6} mm Hg); [Author's designation: Sample 2].
14	54	1962	1100-1800	± 4	Polished using rouge in wax on a buffing wheel; measured in vacuum (10^{-4} to 10^{-6} mm Hg); [Author's designation: Sample No. 3].
15	54	1962	800-1300	± 4	Polished using fine aluminum oxide powder on a circular rotatable drum with a rotating lap; measured in vacuum (10^{-4} to 10^{-5} mm Hg); cycle 1; [Author's designation: Sample No. 5].
16	54	1962	800-1300	± 4	Above specimen and conditions; cycle 2.
17	54	1962	1400-1800	± 4	Different sample, same as curve 15 specimen and conditions; cycle 1; [Author's designation: Sample No. 6].
18	54	1962	1100-1300	± 4	Above specimen and conditions; cycle 2.

SPECIFICATION TABLE NO. 132 (continued)

Curve No.	Ref. No.	Year	Temperature Range, K	Reported Error, %	Composition (weight percent), Specifications and Remarks
19	54	1962	1800	± 4	Above specimen and conditions; cycle 3.
20	54	1962	1300-1500	± 4	Above specimen and conditions; cycle 4.
21	54	1962	1000-2000	± 4	Above specimen and conditions; cycle 5.
22	12	1962	385.6-1075.1	± 2.7	Grit blasted with aluminum oxide No. 90 (PMC-3043A); measured in vacuum (<2.9 x 10^{-6} mm Hg); Run No. 1.
23	12	1962	1061.1-1251.5	± 2.7	Above specimen and conditions; Run No. 2A.
24	12	1962	1255.1-1235.9	± 2.7	Above specimen and conditions; Run No. 2B.
25	12	1962	491.2-1385.2	± 2.7	Vapor-blasted with Techline Liquabrasive, PMC-3067, grit No. 325; measured in vacuum (<5 x 10^{-6} mm Hg); Run No. 1.
26	12	1962	545.2-1375.7	± 2.7	Above specimen and conditions; Run No. 2.
27	12	1962	412-1373	± 2.7	Above specimen and conditions; Run No. 3.
28	12	1962	410-1244	± 2.7	Above specimen and conditions; Run No. 4A.
29	12	1962	1378-1273	± 2.7	Above specimen and conditions; Run No. 4B.
30	12	1962	429.2-1401.2	± 2.7	Chemically cleaned; measured in vacuum (<5 x 10^{-6} mm Hg); Run No. 1.
31	12	1962	449.7-1405.2	± 2.7	Above specimen and conditions; Run No. 2.
32	12	1962	407.2-1374.2	± 2.7	Above specimen and conditions; Run No. 3A.
33	12	1962	1002.4-1169.2	± 2.7	Above specimen and conditions; Run No. 3B.
34	12	1962	1054-1536	± 2.3	As received; measured in vacuum (<2 x 10^{-6} mm Hg); Run No. 1A.
35	12	1962	1539-1100	± 2.3	Above specimen and conditions; Run No. 1B.
36	12	1962	1242-1540	± 2.3	Above specimen and conditions; Run No. 2.
37	12	1962	1045-1539	± 2.7	As received; measured in vacuum (<2 x 10^{-6} mm Hg); Run No. 1A.
38	12	1962	1535-1097	± 2.7	Above specimen and conditions; Run No. 1B.
39	12	1962	1239-1541	± 2.7	Above specimen and conditions; Run No. 2.
40	12	1962	1368-998	± 2.7	Grit blasted with aluminum oxide No. 90 (PMC-3043A); measured in vacuum (<5.1 x 10^{-6} mm Hg); Run No. 1.

DATA TABLE NO. 132 HEMISPHERICAL TOTAL EMITTANCE OF MOLYBDENUM

[Temperature, T, K; Emittance, ϵ]

CURVE 1

T	ϵ
468	0.07
668	0.09
873	0.12
1093	0.13

CURVE 2

T	ϵ
1544	0.280
1686	0.300
1822	0.315
1967	0.320
2033	0.325
2103	0.325
2172	0.325

CURVE 3

T	ϵ
589	0.785
644	0.830
700	0.825
755	0.810
811	0.805

CURVE 4

T	ϵ
673	0.065
873	0.115
1073	0.175
1273	0.240
1473	0.315
1673	0.390
1773	0.430

CURVE 5

T	ϵ
773	0.215
873	0.245
1073	0.300
1273	0.355
1473	0.410
1493	0.415

CURVE 6

T	ϵ
2300	0.276
2370	0.274
2400	0.276

CURVE 6 (cont.)

T	ϵ
2440	0.279
2500	0.278
2565	0.282
2600	0.282
2630	0.281
2655	0.281
2695	0.282
2760	0.285
2800	0.285
2825	0.285
2900	0.285

CURVE 7*

T	ϵ
1540	0.275
1690	0.300
1830	0.310
1970	0.320
2040	0.325
2110	0.326
2180	0.326

CURVE 8

T	ϵ
1506	0.1580
1588	0.1650
1638	0.1850
1738	0.1925
1750	0.1825
1775	0.1875
1825	0.1975
1856	0.1825
1906	0.1987
1912	0.1912
1950	0.2075
1975	0.2200
2006	0.2125
2025	0.2250
2031	0.2200
2062	0.2150
2081	0.2225
2112	0.2225
2137	0.2200
2137	0.2275
2162	0.2225

CURVE 8 (cont.)

T	ϵ
2175	0.2325
2212	0.2337
2225	0.2375
2218	0.2400
2237	0.2450
2275	0.2325
2300	0.2400
2356	0.2475
2400	0.2475
2406	0.2600
2412	0.2575
2518	0.2575
2506	0.2687
2575	0.2675
2612	0.2700
2662	0.2712
2650	0.2662
2700	0.2750
2750	0.2750
2825	0.2812

CURVE 9

T	ϵ
1200	0.117
1250	0.123
1300	0.130
1350	0.136
1400	0.143
1450	0.149
1500	0.155
1550	0.161
1600	0.167
1650	0.173
1700	0.178

CURVE 10

T	ϵ
1200	0.124
1250	0.136
1300	0.142
1350	0.149
1400	0.156
1450	0.162
1500	0.168
1550	0.174
1600	0.180

CURVE 10 (cont.)

T	ϵ
1650	0.186
1700	0.192

CURVE 11

T	ϵ
1200	0.143
1250	0.150
1300	0.157
1350	0.164
1400	0.171
1450	0.178
1500	0.185
1550	0.192
1600	0.198
1650	0.205
1700	0.211

CURVE 12

T	ϵ
1070	0.190
1100	0.200
1200	0.210
1205	0.210
1210	0.215
1300	0.220
1300	0.225
1305	0.223
1380	0.230
1385	0.233
1405	0.240
1410	0.237
1495	0.245
1500	0.245
1500	0.245*
1600	0.260
1600	0.263*
1600	0.265
1705	0.275
1705	0.275*
1805	0.285
1900	0.245
1990	0.305

CURVE 13

T	ϵ
1185	0.217
1200	0.217

CURVE 13 (cont.)

T	ϵ
1290	0.230
1305	0.230
1370	0.237
1390	0.240
1500	0.257
1600	0.277
1705	0.285
1810	0.300
1905	0.310

CURVE 14*

T	ϵ
1100	0.195
1195	0.207
1400	0.235
1600	0.255
1800	0.280

CURVE 15*

T	ϵ
800	0.085
900	0.090
1000	0.100
1100	0.113
1200	0.132
1300	0.157
1310	0.170
1310	0.177
1310	0.185
1300	0.210
1300	0.217
1300	0.222

CURVE 16

T	ϵ
800	0.155
900	0.165
1000	0.180
1100	0.192
1200	0.205
1300	0.222*

CURVE 17*

T	ϵ
1400	0.160
1600	0.190
1800	0.217

CURVE 18

T	ϵ
1100	0.115
1200	0.135*
1300	0.157*
1300	0.185
1300	0.200
1300	0.240

CURVE 19

T	ϵ
1800	0.300
1800	0.275
1800	0.273
1800	0.285

CURVE 20*

T	ϵ
1300	0.215
1300	0.230
1500	0.262

CURVE 21*

T	ϵ
1000	0.185
1100	0.200
1200	0.215
1300	0.230
1400	0.247
1600	0.280
1700	0.295
1800	0.305
1900	0.310
2000	0.312

CURVE 22

T	ϵ
385.6	0.272
446.7	0.276
485.6	0.268
514.6	0.272
554.2	0.277
587.8	0.280
621.3	0.277
655.0	0.278
688.9	0.284
716.6	0.295
750.4	0.298
751.8	0.297*

CURVE 22 (cont.)

T	ϵ
778.2	0.303
808.5	0.310
845.3	0.312
870.6	0.312
904.0	0.320
952.2	0.330
975.7	0.329
1001.7	0.334
1030.2	0.339
1071.5	0.337
1075.1	0.330

CURVE 23

T	ϵ
1061.1	0.323
1092.2	0.329
1123.6	0.326
1134.1	0.335
1156.4	0.344
1210.2	0.341
1234.8	0.346
1241.6	0.339
1247.8	0.332
1251.5	0.328

CURVE 24*

T	ϵ
1255.1	0.324
1235.9	0.320

CURVE 25

T	ϵ
491.2	0.082
625.2	0.099
762.2	0.109
900.2	0.133
1018.2	0.141
1161.2	0.163
1270.2	0.173
1385.2	0.180

CURVE 26*

T	ϵ
545.2	0.055
685.7	0.065
813.2	0.082
936.2	0.101

* Not shown on plot

CURVE 26 (cont.)

T	ϵ
545.2	0.055
685.7	0.065
813.2	0.082
936.2	0.101
1084.2	0.126
1191.7	0.143
1308.7	0.163
1375.7	0.173

CURVE 27

T	ϵ
412	0.043
545	0.052
675	0.068
797	0.081
909	0.096
1007	0.111
1131	0.129
1255	0.148
1373	0.172

CURVE 28*

T	ϵ
410	0.038
553	0.050
646	0.061
768	0.073
892	0.088
990	0.100
1114	0.121
1244	0.139

CURVE 29*

T	ϵ
1378	0.163
1273	0.144

CURVE 30

T	ϵ
429.2	0.056
520.2	0.063
648.2	0.073
763.2	0.082
919.2	0.097
1054.2	0.112
1198.2	0.128
1307.7	0.139
1401.2	0.147

CURVE 31*

T	ϵ
449.7	0.043
594.2	0.054
696.2	0.062
784.2	0.069
913.7	0.081
1052.9	0.098
1177.2	0.112
1318.2	0.135
1405.2	0.146

CURVE 32*

T	ϵ
407.2	0.034
502.8	0.041
590.2	0.055
767.0	0.066
889.2	0.077
1159.2	0.113
1283.2	0.130
1374.2	0.142

CURVE 33

T	ϵ
1002.4	0.130
1169.2	0.112

CURVE 34

T	ϵ
1054	0.118
1089	0.123
1145	0.128
1209	0.132
1263	0.136
1315	0.142
1374	0.147
1426	0.158
1538	0.165

CURVE 35*

T	ϵ
1539	0.165
1481	0.156
1431	0.149
1387	0.143
1335	0.135
1290	0.128
1243	0.122
1188	0.115

CURVE 35 (cont.)

T	ϵ
1135	0.109
1100	0.104

CURVE 36*

T	ϵ
1242	0.122
1290	0.128
1337	0.134
1387	0.143
1431	0.149
1481	0.156
1540	0.165

CURVE 37*

T	ϵ
1045	0.122
1083	0.125
1140	0.131
1201	0.135
1258	0.139
1311	0.143
1366	0.150
1475	0.158
1539	0.165

CURVE 38*

T	ϵ
1535	0.167
1480	0.156
1429	0.150
1385	0.143
1333	0.136
1264	0.131
1237	0.124
1184	0.117
1131	0.110
1097	0.105

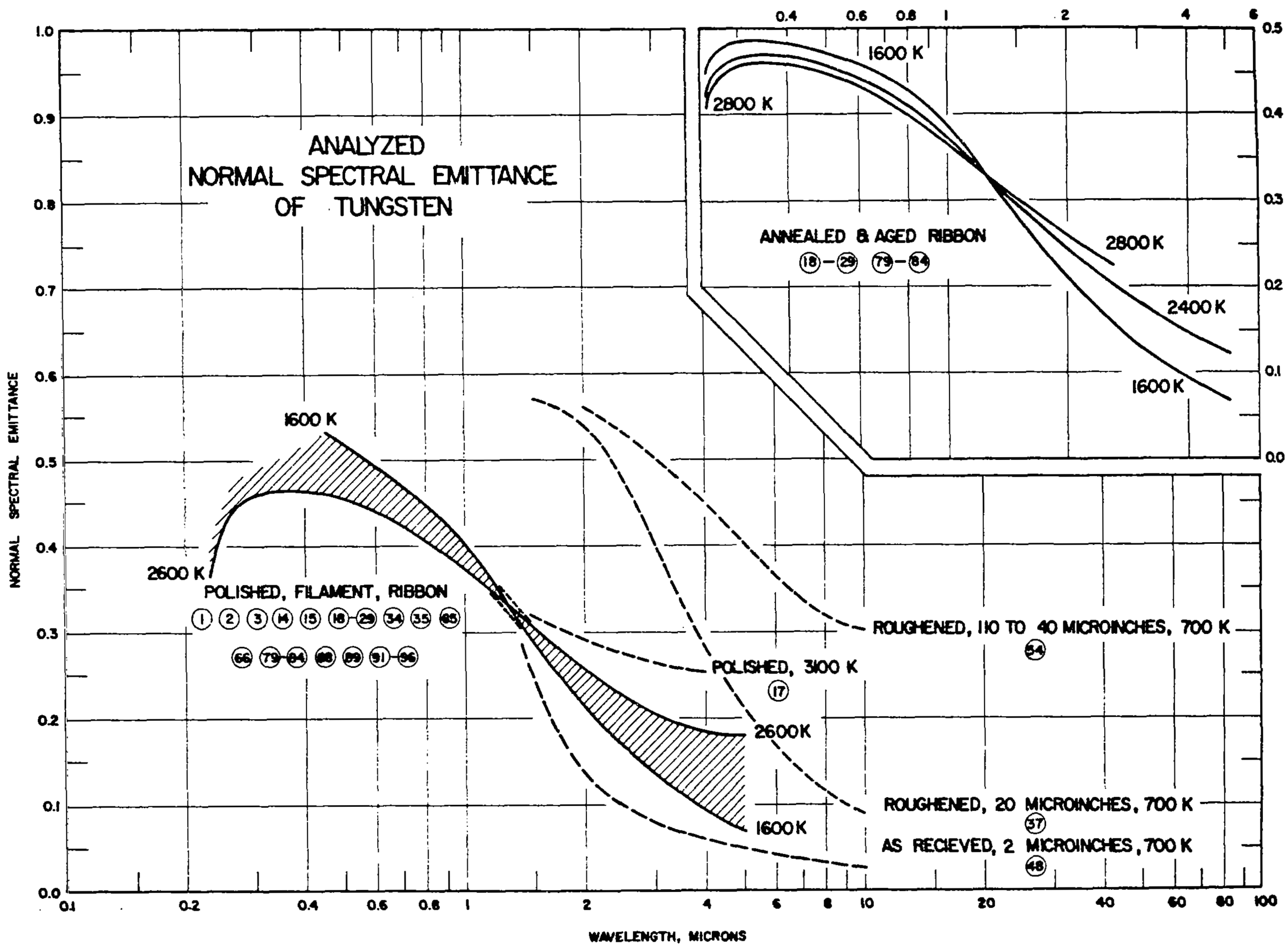
CURVE 39*

T	ϵ
1239	0.124
1286	0.130
1333	0.136
1385	0.144
1429	0.150
1480	0.156
1541	0.164

CURVE 40

T	ϵ
1368	0.314
1308	0.302
1266	0.290
1233	0.281
1204	0.280
1180	0.269
1149	0.264
1125	0.260
1093	0.253
1063	0.248
1034	0.242
1004	0.235
998	0.236

* Not shown on plot


ANALYZED
NORMAL SPECTRAL EMITTANCE
OF TUNGSTEN
NORMAL SPECTRAL EMITTANCE
WAVELENGTH, MICRONS
1600 K
2600 K
POLISHED, FILAMENT, RIBBON
1 2 3 14 15 18-29 34 35 85
66 79-84 88 89 91-96
ANNEALED & AGED RIBBON
18-29 79-84
2800 K
1600 K
2800 K
2400 K
1600 K
ROUGHENED, 110 TO 40 MICROINCHES, 700 K
54
POLISHED, 3100 K
17
2600K
1600K
ROUGHENED, 20 MICROINCHES, 700 K
37
AS RECIEVED, 2 MICROINCHES, 700 K
48

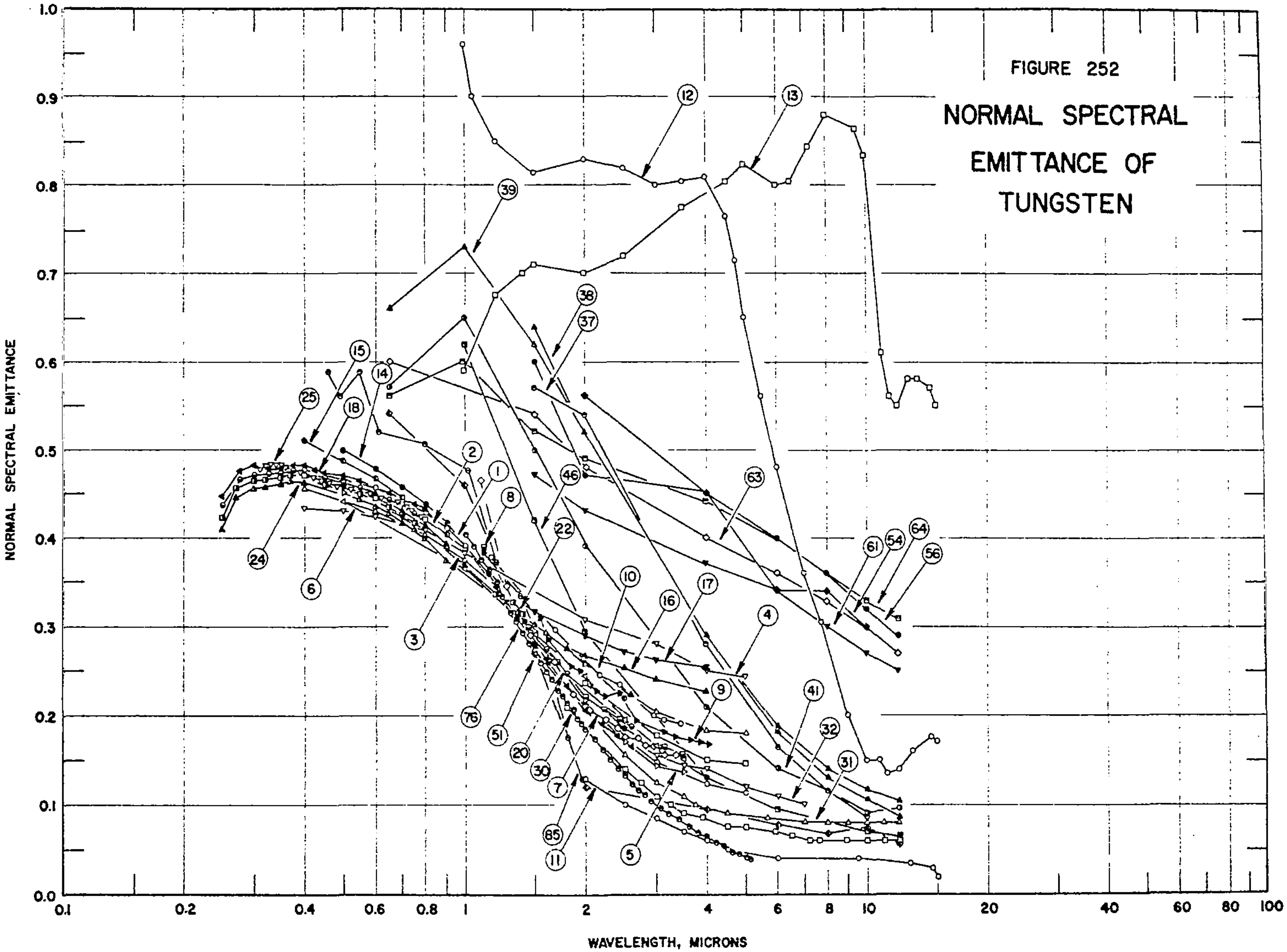


FIGURE 252
NORMAL SPECTRAL EMITTANCE OF TUNGSTEN

SPECIFICATION TABLE NO. 252 NORMAL SPECTRAL EMITTANCE OF TUNGSTEN

Curve No.	Ref. No.	Year	Temperature K	Wavelength Range, μ	Geometry θ'	Reported Error, %	Composition (weight percent), Specifications and Remarks
1	112	1963	1605	0. 4-5. 0	$\sim 0^\circ$		Polished single crystal tungsten; measured in argon (1140 mm Hg) along 002 crystal plane; data extracted from smooth curve.
2	112	1963	2140	0. 4-5. 0	$\sim 0^\circ$		Above specimen and conditions.
3	112	1963	2639	0. 4-5. 0	$\sim 0^\circ$		Above specimen and conditions.
4	112	1963	2650	0. 4-5. 0	$\sim 0^\circ$		Above specimen and conditions.
5	113	1961	1830	0. 5-3. 5	$\sim 0^\circ$		Measured in argon (760 mm Hg); data extracted from smooth curve.
6	113	1961	2040	0. 5-3. 5	$\sim 0^\circ$		Above specimen and conditions.
7	113	1961	1316	1. 10-3. 47	$\sim 0^\circ$		Trace of surface oxidation observed; measured in vacuum.
8	113	1961	1340	1. 12-3. 48	$\sim 0^\circ$		Above specimen and conditions.
9	113	1961	1382	1. 13-4. 04	$\sim 0^\circ$		Above specimen and conditions except measured in argon (760 mm Hg).
10	113	1961	1429	1. 16-3. 48	$\sim 0^\circ$		Above specimen and conditions.
11	86	1961	523	2. 00-15. 00	$\sim 0^\circ$	± 5	As received; data extracted from smooth curve.
12	86	1961	773	1. 00-15. 00	$\sim 0^\circ$		Different sample, same as curve 11 specimen and conditions.
13	86	1961	1023	1. 00-15. 00	$\sim 0^\circ$	± 5	Different sample, same as curve 11 specimen and conditions.
14	95	1963	1600	0. 50-4. 00	$\sim 0^\circ$		99. 9 W from Carbide Specialty Co. ; polished with carbide paper of 240, 400, and 600 grit, respectively, and then with silk cloth and felt cloth; washed in acetone, then alcohol, and dried with dry nitrogen; data extracted from smooth curve.
15	95	1963	2000	0. 40-4. 00	$\sim 0^\circ$		Above specimen and conditions.
16	95	1963	2800	0. 40-4. 00	$\sim 0^\circ$		Above specimen and conditions.
17	95	1963	3100	0. 40-4. 00	$\sim 0^\circ$		Above specimen and conditions.
18	114	1954	1600	0. 25-2. 60	$\sim 0^\circ$	0. 1	0. 014 - 0. 015 Fe, 0. 004 - 0. 008 Si, 0. 001 - 0. 003 Mn, 0. 0003 - 0. 0006 Mg, W balance; heated at 2400 K, treated in hydrogen, annealed at 2400 K for 100 hrs; measured in vacuum (5×10^{-6} mm Hg); data extracted from smooth curve.
19	114	1954	1800	0. 25-2. 60	$\sim 0^\circ$	0. 1	Above specimen and conditions.
20	114	1954	2000	0. 25-2. 60	$\sim 0^\circ$	0. 1	Above specimen and conditions.
21	114	1954	2200	0. 25-2. 60	$\sim 0^\circ$	0. 1	Above specimen and conditions.
22	114	1954	2400	0. 25-2. 60	$\sim 0^\circ$	0. 1	Above specimen and conditions.
23	114	1954	2600	0. 25-2. 60	$\sim 0^\circ$	0. 1	Above specimen and conditions except measured in argon (500 mm Hg).
24	114	1954	2800	0. 25-2. 60	$\sim 0^\circ$	0. 1	Above specimen and conditions.
25	115	1959	1600	0. 310-0. 800	$\sim 0^\circ$		Better than 99. 99 percent pure; heated at 2750 K for 1/2 hr in vacuum, then annealed at 2500 K for 30 hrs, at 2800 K for 1/2 hr, and at 2500 K for 20 hrs; measured in vacuum (3×10^{-9} to 9.5×10^{-8} mm Hg).

SPECIFICATION TABLE NO. 252 (continued)

Curve No.	Ref. No.	Year	Temperature K	Wavelength Range, μ	Geometry θ'	Reported Error, %	Composition (weight percent), Specifications and Remarks
26	115	1959	1800	0.310-0.800	$\sim 0^\circ$		Above specimen and conditions.
27	115	1959	2000	0.310-0.800	$\sim 0^\circ$		Above specimen and conditions.
28	115	1959	2200	0.310-0.800	$\sim 0^\circ$		Above specimen and conditions.
29	115	1959	2400	0.310-0.800	$\sim 0^\circ$		Above specimen and conditions.
30	12	1962	1200	0.50-12.00	$\sim 0^\circ$	± 3	Measured in vacuum ($< 10^{-7}$ mm Hg).
31	12	1962	1428	0.50-12.00	$\sim 0^\circ$	± 3	Above specimen and conditions.
32	12	1962	1972	0.45-7.00	$\sim 0^\circ$	± 3	Above specimen and conditions.
33	241	1963	1660	1.10-1.70	0	< 1	Single crystal; oriented so that surface of interest coincided with closed packed plane; optically polished; heated at several hundred degrees above temperature of interest in 90 Ar + 10 H atm; computed from optical constants.
34	241	1963	1790	0.9-1.7	0°	< 1	Above specimen and conditions.
35	241	1963	1950	0.90-1.70	0°	< 1	Above specimen and conditions.
36	241	1963	2050	0.90-1.70	0°	< 1	Above specimen and conditions.
37	227	1964	693	1.5-10	$\sim 0^\circ$		Impurities < 40 ppm; grit blasted; surface roughness 17 microinches rms, 21 microinches rms after emittance test; preheated in vacuum at 1000 K for 0.5 hr; measured in vacuum (8×10^{-6} mm Hg); [Author's designation: Sample 2].
38	227	1964	860	1.5-12	$\sim 0^\circ$		Above specimen and conditions.
39	227	1964	1033	0.65-12	$\sim 0^\circ$		Above specimen and conditions.
40	227	1964	1200	0.65-12	$\sim 0^\circ$		Above specimen and conditions.
41	227	1964	1373	0.65-12	$\sim 0^\circ$		Above specimen and conditions.
42	227	1964	1603	0.65-4	$\sim 0^\circ$		Above specimen and conditions.
43	227	1964	698	1.5-10	$\sim 0^\circ$		Above specimen and conditions except second temperature cycle.
44	227	1964	860	1.5-10	$\sim 0^\circ$		Above specimen and conditions.
45	227	1964	1029	1-12	$\sim 0^\circ$		Above specimen and conditions.
46	227	1964	1196	1-12	$\sim 0^\circ$		Above specimen and conditions.
47	227	1964	1378	1.5-4	$\sim 0^\circ$		Above specimen and conditions.
48	227	1964	702	1.5-10	$\sim 0^\circ$		Impurities < 40 ppm; as received; surface roughness 1.5 microinches rms before emittance test, 2.4 microinches rms after emittance; preheated in vacuum for 2 hrs; measured in vacuum (7×10^{-6} mm Hg); [Author's designation: Sample 1].
49	227	1964	870	1.5-10	$\sim 0^\circ$		Above specimen and conditions.
50	227	1964	1039	1.5-12	$\sim 0^\circ$		Above specimen and conditions.

SPECIFICATION TABLE NO. 252 (continued)

Curve No.	Ref. No.	Year	Temperature K	Wavelength Range, μ	Geometry θ'	Reported Error, %	Composition (weight percent), Specifications and Remarks
51	227	1964	1208	0.65-12	~0°		Above specimen and conditions.
52	227	1964	1378	0.65-4	~0°		Above specimen and conditions.
53	227	1964	1603	0.65-4	~0°		Above specimen and conditions.
54	227	1962	692	2-10	~0°		Impurities <40 ppm; grit blasted; surface roughness 110 microinches rms before emittance test, 38 microinches after emittance test; preheated in vacuum at 1000 K for 0.5 hr; measured in vacuum (5×10^{-5} mm Hg); $\omega' = 3.4 \times 10^{-4}$ sr.; [Author's designation: Sample 3].
55	227	1964	863	1.5-12	~0°		Above specimen and conditions.
56	227	1964	1040	1.5-12	~0°		Above specimen and conditions.
57	227	1964	1214	0.65-12	~0°		Above specimen and conditions.
58	227	1964	1383	0.65-12	~0°		Above specimen and conditions.
59	227	1964	699	1.5-10	~0°		Above specimen and conditions.
60	227	1964	529	1.5-10	~0°		Above specimen and conditions.
61	227	1964	700	1.5-12	~0°		Above specimen and conditions.
62	227	1964	858	1.5-12	~0°		Above specimen and conditions.
63	227	1964	1198	0.65-12	~0°		Above specimen and conditions.
64	227	1964	1358	0.65-12	~0°		Above specimen and conditions.
65	76	1962	1600	0.50-4.00	~0°		Prepared from micronized powder; hot pressed at >2273 K; sintered, polished, etched, then degassed by heating to ~973 K; measured in argon; data extracted from smooth curve.
66	76	1962	2000	0.40-4.00	~0°		Above specimen and conditions.
67	76	1962	2800	0.40-4.00	~0°		Above specimen and conditions.
68	76	1962	3100	0.40-4.00	~0°		Above specimen and conditions.
69	239	1959	1429	1.157-3.486	~0°	5	Highly polished; measured in argon.
70	239	1959	1382	1.127-4.038	~0°	5	Different sample, same as above specimen and conditions.
71	239	1959	1340	1.120-3.485	~0°	5	Different sample, same as above specimen and conditions.
72	239	1959	1316	1.096-3.459	~0°	5	Different sample, same as above specimen and conditions.
73	237	1965	1800	0.467-0.698	~0°		Chemically pure; measured in vacuum; authors assumed $\epsilon = 1-\rho$ and computed ρ from optical constants.
74	237	1965	2150	0.467-0.698	~0°		Above specimen and conditions.
75	237	1965	2520	0.467-0.698	~0°		Above specimen and conditions.

SPECIFICATION TABLE NO. 252 (continued)

Curve No.	Ref. No.	Year	Temperature K	Wavelength Range, μ	Geometry θ'	Reported Error, %	Composition (weight percent), Specifications and Remarks
76	338	1965	1244	1.00-5.10	0°		Ribbon; black body (at 1336 K) used as reference standard.
77	338	1965	1339	1.00-5.10	0°		Above specimen and conditions.
78	338	1965	1413	1.00-5.10	0°		Above specimen and conditions.
79	338	1965	1629	1.00-5.10	0°		Above specimen and conditions.
80	338	1965	1833	1.00-5.10	0°		Above specimen and conditions.
81	338	1965	2002	1.00-5.10	0°		Above specimen and conditions.
82	338	1965	2160	1.00-5.10	0°		Above specimen and conditions.
83	338	1965	2327	1.00-5.10	0°		Above specimen and conditions.
84	338	1965	2441	1.00-5.10	0°		Above specimen and conditions.
85	323	1966	300	0.46-2.00	0°		Filament (0.25-0.32 mm in dia); baked for 1 hr at 798 K in vacuum, cooled, heated for 5-10 min in vacuum, and cooled; measured in argon (600 mm Hg); data calculated from optical constants.
86	323	1966	1100	0.45-2.00	0°		Above specimen and conditions.
87	323	1966	1500	0.46-2.00	0°		Above specimen and conditions.
88	323	1966	2000	0.46-2.00	0°		Above specimen and conditions.
89	323	1966	2500	0.46-2.00	0°		Above specimen and conditions.
90	331	1917	2143	0.3478-0.5641	~0°	5	Measured in nitrogen; data is mean of three or more measurements.
91	333	1962	1600	0.230-0.269	~0°		Tungsten ribbon; data extracted from smooth curve
92	333	1962	1800	0.229-0.270	~0°		Above specimen and conditions.
93	333	1962	2000	0.229-0.271	~0°		Above specimen and conditions.
94	333	1962	2200	0.231-0.268	~0°		Above specimen and conditions.
95	333	1962	2400	0.231-0.268	~0°		Above specimen and conditions.
96	333	1962	2600	0.231-0.269	~0°		Above specimen and conditions.
97	333	1962	2800	0.229-0.268	~0°		Above specimen and conditions.

DATA TABLE NO. 252 NORMAL SPECTRAL EMITTANCE OF TUNGSTEN

[Wavelength, λ, μ; Emittance, ϵ; Temperature, T, K]

CURVE 1
T = 1605

λ	ϵ
0.4	0.478
0.6	0.455
0.8	0.427
0.9	0.410
1.0	0.390
2.0	0.210
3.0	0.147
4.0	0.123
5.0	0.113

CURVE 2
T = 2140

λ	ϵ
0.4	0.470
0.6	0.445
0.8	0.422
1.0	0.387
2.0	0.237
3.0	0.177
4.0	0.150
5.0	0.145

CURVE 3
T = 2639

λ	ϵ
0.4	0.455
0.6	0.430
0.8	0.403
1.0	0.375
2.0	0.258
3.0	0.205
4.0	0.183
5.0	0.180

CURVE 4
T = 2650

λ	ϵ
0.4	0.433
0.5	0.430
0.6	0.425
0.8	0.405
1.0	0.383

CURVE 4 (cont.)

λ	ϵ
2.0	0.308
3.0	0.270
4.0	0.250
5.0	0.243

CURVE 5
T = 1830

λ	ϵ
0.5	0.450
1.0	0.380*
1.5	0.295
2.0	0.218
2.5	0.170
3.0	0.146
3.5	0.138

CURVE 6
T = 2040

λ	ϵ
0.5	0.440
1.0	0.365
1.5	0.293
2.0	0.244
2.5	0.195
3.0	0.165
3.5	0.150

CURVE 7
T = 1316

λ	ϵ
1.10	0.465
1.27	0.345
1.47	0.290
1.67	0.260
1.86	0.225
2.05	0.208
2.24	0.195
2.40	0.185
2.50	0.175
2.70	0.174
2.82	0.167
2.97	0.165
3.10	0.160

CURVE 7 (cont.)

λ	ϵ
3.12	0.156
3.35	0.155
3.47	0.150*

CURVE 8
T = 1340

λ	ϵ
1.12	0.390
1.45	0.300
1.70	0.260
2.00	0.220
2.22	0.208
2.42	0.195
2.92	0.165*
3.13	0.164
3.48	0.156

CURVE 9
T = 1382

λ	ϵ
1.13	0.382
1.55	0.310
1.62	0.285
1.70	0.263*
1.85	0.255
1.94	0.250
2.14	0.228
2.25	0.221
2.43	0.225
2.68	0.193
2.92	0.185
3.12	0.183
3.33	0.175
3.62	0.172
3.84	0.170
4.04	0.169

CURVE 10
T = 1429

λ	ϵ
1.16	0.379
1.68	0.299
1.99	0.263

CURVE 10 (cont.)

λ	ϵ
2.17	0.246
2.43	0.235
2.93	0.200
3.12	0.195
3.48	0.190

CURVE 11
T = 523

λ	ϵ
2.00	0.130
2.50	0.100
3.00	0.085
3.50	0.070
4.00	0.060
4.50	0.050
6.00	0.040
9.50	0.040
12.75	0.035
14.50	0.030
15.00	0.020

CURVE 12
T = 773

λ	ϵ
1.00	0.960
1.05	0.900
1.20	0.850
1.50	0.815
2.00	0.830
2.50	0.820
3.00	0.800
3.50	0.805
4.00	0.810
4.50	0.765
4.75	0.715
5.00	0.650
5.50	0.560
6.00	0.480
7.00	0.360
7.75	0.305
9.00	0.200
10.00	0.150
10.75	0.150

CURVE 12 (cont.)

λ	ϵ
11.25	0.135
12.00	0.140
13.00	0.160
14.50	0.175
15.00	0.170

CURVE 13
T = 1023

λ	ϵ
1.00	0.590
1.20	0.675
1.40	0.700
1.50	0.710
2.00	0.700
2.50	0.720
3.50	0.775
4.50	0.805
5.00	0.825
6.00	0.800
6.50	0.805
7.25	0.845
8.00	0.880
9.50	0.865
10.00	0.835
11.00	0.610
11.50	0.560
12.00	0.550
12.75	0.580
13.50	0.580
14.50	0.570
15.00	0.550

CURVE 14
T = 1600

λ	ϵ
0.50	0.500
0.60	0.478
0.70	0.457
0.80	0.437
0.90	0.415
1.00	0.390*
1.15	0.360
1.42	0.306

CURVE 14 (cont.)

λ	ϵ
1.50	0.280
2.00	0.208*
2.50	0.184
3.00	0.163*
4.00	0.130

CURVE 15
T = 2000

λ	ϵ
0.40	0.510
0.50	0.488
0.60	0.466
0.70	0.445
0.80	0.425*
0.90	0.404
1.00	0.381*
1.42	0.306*
1.50	0.282*
2.00	0.236*
2.50	0.220
3.00	0.204*
4.00	0.180*

CURVE 16
T = 2800

λ	ϵ
0.40	0.478*
0.50	0.467
0.60	0.450
0.70	0.430
0.80	0.412
0.90	0.393
1.00	0.367
1.42	0.306*
1.50	0.294*
2.00	0.267
2.50	0.252
3.00	0.240
4.00	0.228

CURVE 17
T = 3100

λ	ϵ
0.40	0.472*
0.50	0.458
0.60	0.442*
0.70	0.426
0.80	0.412*
0.90	0.396*
1.00	0.380*
1.50	0.318
2.00	0.290
2.50	0.272
3.00	0.262
4.00	0.252

CURVE 18
T = 1600

λ	ϵ
0.25	0.448
0.27	0.476
0.30	0.482
0.32	0.478
0.35	0.479
0.37	0.482
0.40	0.481
0.42	0.478
0.45	0.474
0.50	0.469
0.55	0.464
0.60	0.456*
0.65	0.450
0.70	0.444*
0.75	0.438
0.80	0.432
0.90	0.412*
1.00	0.390*
1.20	0.344
1.27	0.328
1.35	0.310
1.50	0.280*
1.60	0.263
1.80	0.234
2.00	0.210*
2.20	0.190

CURVE 18 (cont.)

λ	ϵ
2.40	0.176
2.60	0.164

CURVE 19*
T = 1800

λ	ϵ
0.25	0.442
0.27	0.471
0.30	0.478
0.32	0.476
0.35	0.476
0.37	0.479
0.40	0.478
0.45	0.470
0.50	0.466
0.55	0.460
0.60	0.452
0.65	0.446
0.70	0.440
0.75	0.434
0.80	0.426
0.90	0.406
1.00	0.386
1.20	0.345
1.27	0.328
1.35	0.312
1.50	0.284
1.60	0.269
1.80	0.242
2.40	0.187
2.60	0.175

CURVE 20
T = 2000

λ	ϵ
0.25	0.436
0.27	0.466
0.30	0.470
0.32	0.472
0.35	0.473
0.37	0.476
0.40	0.474*
0.45	0.467

* Not shown on plot

DATA TABLE NO. 252 (continued)

CURVE 20 (cont.) T = 2000

λ	ϵ
0.50	0.462
0.55	0.456
0.60	0.448*
0.65	0.442
0.75	0.428
0.80	0.420*
0.90	0.400*
1.00	0.382*
1.20	0.342*
1.27	0.328*
1.35	0.313*
1.50	0.288*
1.60	0.273
1.80	0.247
2.40	0.196*
2.60	0.187

CURVE 21* T = 2200

λ	ϵ
0.25	0.430
0.27	0.460
0.30	0.470
0.32	0.468
0.35	0.470
0.37	0.473
0.40	0.470
0.45	0.464
0.50	0.458
0.55	0.453
0.60	0.444
0.65	0.438
0.70	0.432
0.75	0.423
0.80	0.414
0.90	0.396
1.00	0.377
1.20	0.340
1.32	0.328
1.50	0.284
1.60	0.278
1.80	0.255
2.40	0.205
2.60	0.195

CURVE 22 T = 2400

λ	ϵ
0.25	0.422
0.27	0.456
0.30	0.465
0.32	0.465
0.35	0.467
0.37	0.470
0.40	0.468*
0.45	0.460
0.50	0.455*
0.55	0.450
0.60	0.440*
0.65	0.434
0.70	0.428*
0.75	0.418
0.80	0.409*
0.90	0.396*
1.00	0.373*
1.20	0.339
1.32	0.328
1.40	0.313
1.50	0.288*
1.60	0.273*
1.80	0.247*
2.40	0.196*
2.60	0.185*

CURVE 23* T = 2600

λ	ϵ
0.25	0.416
0.27	0.450
0.30	0.460
0.33	0.461
0.35	0.466
0.40	0.464
0.45	0.457
0.50	0.451
0.55	0.446
0.60	0.438
0.65	0.430
0.70	0.423
0.75	0.414
0.80	0.404
0.90	0.388

CURVE 23 (cont.)

λ	ϵ
1.00	0.360
1.20	0.339
1.32	0.328
1.40	0.317
1.50	0.299
1.60	0.288
1.80	0.268
2.40	0.224
2.60	0.214

CURVE 24 T = 2800

λ	ϵ
0.25	0.410
0.27	0.445
0.30	0.456
0.32	0.457
0.35	0.461
0.37	0.463
0.40	0.461
0.45	0.454*
0.50	0.448*
0.55	0.443
0.60	0.434
0.65	0.427
0.70	0.419
0.75	0.410
0.80	0.400
0.90	0.373
1.00	0.367*
1.20	0.337*
1.32	0.328*
1.35	0.318
1.50	0.302
1.60	0.292
1.80	0.274
2.40	0.233*
2.60	0.224

CURVE 25 T = 1600

λ	ϵ
0.310	0.479
0.320	0.482
0.330	0.482

CURVE 25 (cont.)

λ	ϵ
0.340	0.481
0.360	0.480
0.370	0.479*
0.380	0.477*
0.390	0.475
0.400	0.473*
0.420	0.469
0.440	0.465
0.460	0.462
0.480	0.459
0.500	0.457*
0.520	0.455
0.540	0.453*
0.560	0.452
0.580	0.450
0.600	0.447
0.620	0.445
0.640	0.442*
0.660	0.441
0.680	0.440*
0.700	0.437
0.720	0.434
0.740	0.430
0.760	0.427*
0.780	0.424
0.800	0.422*

CURVE 26* T = 1800

λ	ϵ
0.310	0.476
0.320	0.479
0.330	0.480
0.340	0.479
0.350	0.479
0.360	0.478
0.370	0.476
0.380	0.475
0.390	0.473
0.400	0.471
0.420	0.467
0.440	0.463
0.460	0.460
0.480	0.457
0.500	0.455

CURVE 26 (cont.)

λ	ϵ
0.520	0.453
0.540	0.451
0.460	0.449
0.580	0.447
0.600	0.444
0.620	0.441
0.640	0.438
0.660	0.436
0.680	0.435
0.700	0.433
0.720	0.429
0.740	0.426
0.760	0.423
0.780	0.421
0.800	0.419

CURVE 27* T = 2000

λ	ϵ
0.310	0.474
0.320	0.476
0.330	0.477
0.340	0.477
0.350	0.476
0.360	0.475
0.370	0.474
0.380	0.473
0.390	0.471
0.400	0.469
0.420	0.466
0.440	0.462
0.460	0.459
0.480	0.456
0.500	0.453
0.520	0.450
0.540	0.448
0.560	0.446
0.580	0.443
0.600	0.440
0.620	0.437
0.640	0.434
0.660	0.432
0.680	0.430
0.700	0.428
0.720	0.425

CURVE 27 (cont.)

λ	ϵ
0.740	0.422
0.760	0.420
0.780	0.418
0.800	0.416

CURVE 28* T = 2200

λ	ϵ
0.310	0.471
0.320	0.473
0.330	0.474
0.340	0.474
0.350	0.474
0.360	0.473
0.370	0.472
0.380	0.471
0.390	0.469
0.400	0.468
0.420	0.464
0.440	0.461
0.460	0.457
0.480	0.454
0.500	0.451
0.520	0.448
0.540	0.446
0.560	0.443
0.580	0.440
0.600	0.437
0.620	0.433
0.640	0.430
0.660	0.428
0.680	0.426
0.700	0.424
0.720	0.421
0.740	0.419
0.760	0.416
0.780	0.415
0.800	0.413

CURVE 29* T = 2400

λ	ϵ
0.310	0.468
0.320	0.471
0.330	0.472

CURVE 29 (cont.)

λ	ϵ
0.340	0.472
0.350	0.472
0.360	0.471
0.370	0.470
0.380	0.469
0.390	0.467
0.400	0.466
0.420	0.463
0.440	0.459
0.460	0.456
0.480	0.452
0.500	0.449
0.520	0.446
0.540	0.443
0.560	0.441
0.580	0.437
0.600	0.434
0.620	0.430
0.640	0.426
0.660	0.424
0.680	0.421
0.700	0.419
0.720	0.417
0.740	0.415
0.760	0.413
0.780	0.412
0.800	0.411

CURVE 30 T = 1200

λ	ϵ
0.50	0.465*
0.66	0.450*
0.70	0.445*
1.00	0.380*
1.80	0.210
2.50	0.140
2.75	0.125
3.00	0.110
3.25	0.100
3.50	0.090
3.90	0.085
4.50	0.075
5.00	0.075
5.90	0.070

CURVE 30 (cont.)

λ	ϵ
6.45	0.065
7.20	0.060
7.60	0.060
8.90	0.060
10.00	0.060
11.00	0.060
12.00	0.060

CURVE 31 T = 1428

λ	ϵ
0.50	0.456*
0.60	0.445*
0.70	0.428*
1.00	0.380*
1.50	0.275
2.00	0.225*
2.50	0.155
3.00	0.125
3.50	0.110
3.75	0.100
4.50	0.090
5.65	0.085
7.00	0.080
8.00	0.080
9.00	0.080
10.00	0.080
11.00	0.080
12.00	0.080

CURVE 32 T = 1972

λ	ϵ
0.45	0.455*
0.50	0.446*
0.55	0.444*
0.60	0.440*
0.65	0.433*
0.70	0.423*
0.80	0.410*
1.50	0.275*
2.00	0.225*
2.50	0.175*
3.00	0.155
3.50	0.145

* Not shown on plot

DATA TABLE NO. 252 (continued)

CURVE 65*
T = 1600

λ	ε
0.50	0.495
0.70	0.450
0.90	0.410
1.15	0.360
1.50	0.290
1.72	0.240
2.00	0.210
2.10	0.200
2.50	0.185
4.00	0.128

CURVE 66*
T = 2000

λ	ε
0.40	0.505
0.50	0.480
0.70	0.440
0.90	0.400
1.15	0.350
1.50	0.290
1.75	0.260
2.00	0.240
2.50	0.220
4.00	0.180

CURVE 67*
T = 2800

λ	ε
0.40	0.480
0.50	0.460
0.70	0.425
0.90	0.390
1.21	0.330
1.50	0.295
2.00	0.260
3.00	0.231
4.00	0.220

CURVE 68*
T = 3100

λ	ε
0.40	0.470
0.50	0.451
0.70	0.420
0.90	0.390

CURVE 68(cont.)*
T = 3100

λ	ε
1.50	0.320
2.00	0.291
3.00	0.260
4.00	0.240

CURVE 69*
T = 1429

λ	ε
1.157	0.378
1.676	0.298
1.984	0.261
2.164	0.246
2.416	0.235
2.929	0.199
3.122	0.194
3.486	0.189

CURVE 70*
T = 1382

λ	ε
1.127	0.382
1.551	0.302
1.615	0.286
1.693	0.272
1.846	0.255
1.934	0.252
2.135	0.229
2.239	0.223
2.422	0.224
2.685	0.191
2.919	0.184
3.128	0.181
3.335	0.173
3.627	0.171
3.843	0.170
4.038	0.169

CURVE 71*
T = 1340

λ	ε
1.120	0.386
1.449	0.295
1.696	0.262
2.002	0.223
2.204	0.208

CURVE 71(cont.)*
T = 1340

λ	ε
2.420	0.193
2.919	0.165
3.121	0.164
3.485	0.159

CURVE 72*
T = 1316

λ	ε
1.096	0.464
1.264	0.345
1.457	0.290
1.655	0.259
1.860	0.224
2.049	0.206
2.231	0.194
2.389	0.182
2.539	0.175
2.694	0.171
2.823	0.167
2.970	0.165
3.092	0.158
3.220	0.154
3.340	0.154
3.459	0.150

CURVE 73*
T = 1800

λ	ε
0.467	0.470
0.499	0.466
0.548	0.460
0.578	0.456
0.654	0.445
0.698	0.441

CURVE 74*
T = 2150

λ	ε
0.467	0.463
0.499	0.460
0.548	0.453
0.578	0.449
0.654	0.437
0.698	0.431

CURVE 75*
T = 2520

λ	ε
0.467	0.454
0.499	0.452
0.548	0.446
0.578	0.441
0.654	0.429
0.698	0.423

CURVE 76
T = 1244

λ	ε
1.00	0.402
1.05	0.389
1.10	0.373
1.15	0.360
1.20	0.345
1.24	0.333
1.30	0.318
1.35	0.305
1.40	0.292
1.45	0.280
1.50	0.269*
1.55	0.259
1.60	0.249
1.65	0.240
1.70	0.231
1.75	0.222
1.80	0.214
1.85	0.206
1.90	0.198
1.95	0.191
2.00	0.184
2.10	0.172
2.20	0.161
2.30	0.150
2.40	0.141
2.50	0.133
2.60	0.124
2.70	0.117
2.80	0.110
2.90	0.104
3.00	0.099
3.20	0.089
3.40	0.082
3.60	0.075
3.80	0.068

CURVE 76(cont.)
T = 1244

λ	ε
4.00	0.063
4.20	0.058
4.40	0.053
4.60	0.049
4.80	0.045
5.00	0.041
5.10	0.039

CURVE 77*
T = 1339

λ	ε
1.00	0.398
1.05	0.385
1.10	0.369
1.15	0.358
1.20	0.344
1.24	0.333
1.30	0.319
1.35	0.306
1.40	0.294
1.45	0.283
1.50	0.272
1.55	0.262
1.60	0.253
1.65	0.244
1.70	0.236
1.75	0.227
1.80	0.219
1.85	0.212
1.90	0.204
1.95	0.197
2.00	0.194
2.10	0.180
2.20	0.169
2.30	0.158
2.40	0.149
2.50	0.141
2.60	0.132
2.70	0.125
2.80	0.118
2.90	0.112
3.00	0.106
3.20	0.097
3.40	0.090
3.60	0.082

CURVE 77(cont.)*
T = 1339

λ	ε
3.80	0.076
4.00	0.071
4.20	0.066
4.40	0.061
4.60	0.057
4.80	0.053
5.00	0.048
5.10	0.047

CURVE 78*
T = 1413

λ	ε
1.00	0.396
1.05	0.382
1.10	0.368
1.15	0.357
1.20	0.343
1.24	0.333
1.30	0.320
1.35	0.308
1.40	0.296
1.45	0.286
1.50	0.275
1.55	0.265
1.60	0.256
1.65	0.248
1.70	0.240
1.75	0.232
1.80	0.224
1.85	0.217
1.90	0.209
1.95	0.203
2.00	0.197
2.10	0.186
2.20	0.175
2.30	0.165
2.40	0.156
2.50	0.147
2.60	0.139
2.70	0.132
2.80	0.125
2.90	0.119
3.00	0.114
3.20	0.104
3.40	0.096

CURVE 78(cont.)*
T = 1413

λ	ε
3.60	0.089
3.80	0.083
4.00	0.077
4.20	0.072
4.40	0.067
4.60	0.062
4.80	0.058
5.00	0.054
5.10	0.052

CURVE 79*
T = 1629

λ	ε
1.00	0.388
1.05	0.377
1.10	0.364
1.15	0.354
1.20	0.342
1.24	0.333
1.30	0.321
1.35	0.311
1.40	0.301
1.45	0.292
1.50	0.282
1.55	0.274
1.60	0.265
1.65	0.257
1.70	0.250
1.75	0.242
1.80	0.236
1.85	0.229
1.90	0.222
1.95	0.217
2.00	0.210
2.10	0.199
2.20	0.189
2.30	0.180
2.40	0.171
2.50	0.163
2.60	0.156
2.70	0.150
2.80	0.143
2.90	0.137
3.00	0.132
3.20	0.122

CURVE 79(cont.)*
T = 1629

λ	ε
3.40	0.114
3.60	0.107
3.80	0.100
4.00	0.094
4.20	0.088
4.40	0.083
4.60	0.078
4.80	0.074
5.00	0.070
5.10	0.068

CURVE 80*
T = 1833

λ	ε
1.00	0.382
1.05	0.372
1.10	0.361
1.15	0.352
1.20	0.342
1.24	0.333
1.30	0.322
1.35	0.313
1.40	0.304
1.45	0.296
1.50	0.288
1.55	0.280
1.60	0.273
1.65	0.266
1.70	0.259
1.75	0.252
1.80	0.245
1.85	0.239
1.90	0.233
1.95	0.227
2.00	0.221
2.10	0.211
2.20	0.201
2.30	0.192
2.40	0.184
2.50	0.176
2.60	0.169
2.70	0.163
2.80	0.157
2.90	0.154
3.00	0.146
3.20	0.136

* Not shown on plot

CURVE 65* T = 1600

λ	ε
0.50	0.495
0.70	0.450
0.90	0.410
1.15	0.360
1.50	0.290
1.72	0.240
2.00	0.210
2.10	0.200
2.50	0.185
4.00	0.128

CURVE 66* T = 2000

λ	ε
0.40	0.505
0.50	0.480
0.70	0.440
0.90	0.400
1.15	0.350
1.50	0.290
1.75	0.260
2.00	0.240
2.50	0.220
4.00	0.180

CURVE 67* T = 2800

λ	ε
0.40	0.480
0.50	0.460
0.70	0.425
0.90	0.390
1.21	0.330
1.50	0.295
2.00	0.260
3.00	0.231
4.00	0.220

CURVE 68* T = 3100

λ	ε
0.40	0.470
0.50	0.451
0.70	0.420
0.90	0.390

CURVE 68 (cont.)* T = 3100

λ	ε
1.50	0.320
2.00	0.291
3.00	0.260
4.00	0.240

CURVE 69* T = 1429

λ	ε
1.157	0.378
1.676	0.298
1.984	0.261
2.164	0.246
2.416	0.235
2.929	0.199
3.122	0.194
3.486	0.189

CURVE 70* T = 1382

λ	ε
1.127	0.382
1.551	0.302
1.615	0.286
1.693	0.272
1.846	0.255
1.934	0.252
2.135	0.229
2.239	0.223
2.422	0.224
2.685	0.191
2.919	0.184
3.128	0.181
3.335	0.173
3.627	0.171
3.843	0.170
4.038	0.169

CURVE 71* T = 1340

λ	ε
1.120	0.386
1.449	0.295
1.696	0.262
2.002	0.223
2.204	0.208

CURVE 71 (cont.)* T = 1340

λ	ε
2.420	0.193
2.919	0.165
3.121	0.164
3.485	0.159

CURVE 72* T = 1316

λ	ε
1.096	0.464
1.264	0.345
1.457	0.290
1.655	0.259
1.860	0.224
2.049	0.206
2.231	0.194
2.389	0.182
2.539	0.175
2.694	0.171
2.823	0.167
2.970	0.165
3.092	0.158
3.220	0.154
3.340	0.154
3.459	0.150

CURVE 73* T = 1800

λ	ε
0.467	0.470
0.499	0.466
0.548	0.460
0.578	0.456
0.654	0.445
0.698	0.441

CURVE 74* T = 2150

λ	ε
0.467	0.463
0.499	0.460
0.548	0.453
0.578	0.449
0.654	0.437
0.698	0.431

CURVE 75* T = 2520

λ	ε
0.467	0.454
0.499	0.452
0.548	0.446
0.578	0.441
0.654	0.429
0.698	0.423

CURVE 76 T = 1244

λ	ε
1.00	0.402
1.05	0.389
1.10	0.373
1.15	0.360
1.20	0.345
1.24	0.333
1.30	0.318
1.35	0.305
1.40	0.292
1.45	0.280
1.50	0.269*
1.55	0.259
1.60	0.249
1.65	0.240
1.70	0.231
1.75	0.222
1.80	0.214
1.85	0.206
1.90	0.198
1.95	0.191
2.00	0.184
2.10	0.172
2.20	0.161
2.30	0.150
2.40	0.141
2.50	0.133
2.60	0.124
2.70	0.117
2.80	0.110
2.90	0.104
3.00	0.099
3.20	0.089
3.40	0.082
3.60	0.075
3.80	0.068

CURVE 76 (cont.) T = 1244

λ	ε
4.00	0.063
4.20	0.058
4.40	0.053
4.60	0.049
4.80	0.045
5.00	0.041
5.10	0.039

CURVE 77* T = 1339

λ	ε
1.00	0.398
1.05	0.385
1.10	0.369
1.15	0.358
1.20	0.344
1.24	0.333
1.30	0.319
1.35	0.306
1.40	0.294
1.45	0.283
1.50	0.272
1.55	0.262
1.60	0.253
1.65	0.244
1.70	0.236
1.75	0.227
1.80	0.219
1.85	0.212
1.90	0.204
1.95	0.197
2.00	0.194
2.10	0.180
2.20	0.169
2.30	0.158
2.40	0.149
2.50	0.141
2.60	0.132
2.70	0.125
2.80	0.118
2.90	0.112
3.00	0.106
3.20	0.097
3.40	0.090
3.60	0.082

CURVE 77 (cont.)* T = 1339

λ	ε
3.80	0.076
4.00	0.071
4.20	0.066
4.40	0.061
4.60	0.057
4.80	0.053
5.00	0.048
5.10	0.047

CURVE 78* T = 1413

λ	ε
1.00	0.396
1.05	0.382
1.10	0.368
1.15	0.357
1.20	0.343
1.24	0.333
1.30	0.320
1.35	0.308
1.40	0.296
1.45	0.286
1.50	0.275
1.55	0.265
1.60	0.256
1.65	0.248
1.70	0.240
1.75	0.232
1.80	0.224
1.85	0.217
1.90	0.209
1.95	0.203
2.00	0.197
2.10	0.186
2.20	0.175
2.30	0.165
2.40	0.156
2.50	0.147
2.60	0.139
2.70	0.132
2.80	0.125
2.90	0.119
3.00	0.114
3.20	0.104
3.40	0.096

CURVE 78 (cont.)* T = 1413

λ	ε
3.60	0.089
3.80	0.083
4.00	0.077
4.20	0.072
4.40	0.067
4.60	0.062
4.80	0.058
5.00	0.054
5.10	0.052

CURVE 79* T = 1629

λ	ε
1.00	0.388
1.05	0.377
1.10	0.364
1.15	0.354
1.20	0.342
1.24	0.333
1.30	0.321
1.35	0.311
1.40	0.301
1.45	0.292
1.50	0.282
1.55	0.274
1.60	0.265
1.65	0.257
1.70	0.250
1.75	0.242
1.80	0.236
1.85	0.229
1.90	0.222
1.95	0.217
2.00	0.210
2.10	0.199
2.20	0.189
2.30	0.180
2.40	0.171
2.50	0.163
2.60	0.156
2.70	0.150
2.80	0.143
2.90	0.137
3.00	0.132
3.20	0.122

CURVE 79 (cont.)* T = 1629

λ	ε
3.40	0.114
3.60	0.107
3.80	0.100
4.00	0.094
4.20	0.088
4.40	0.083
4.60	0.078
4.80	0.074
5.00	0.070
5.10	0.068

CURVE 80* T = 1833

λ	ε
1.00	0.382
1.05	0.372
1.10	0.361
1.15	0.352
1.20	0.342
1.24	0.333
1.30	0.322
1.35	0.313
1.40	0.304
1.45	0.296
1.50	0.288
1.55	0.280
1.60	0.273
1.65	0.266
1.70	0.259
1.75	0.252
1.80	0.245
1.85	0.239
1.90	0.233
1.95	0.227
2.00	0.221
2.10	0.211
2.20	0.201
2.30	0.192
2.40	0.184
2.50	0.176
2.60	0.169
2.70	0.163
2.80	0.157
2.90	0.154
3.00	0.146
3.20	0.136

* Not shown on plot

CURVE 80 (cont.)*
T = 1833

λ	ε
3.40	0.128
3.60	0.121
3.80	0.114
4.00	0.108
4.20	0.102
4.40	0.097
4.60	0.092
4.80	0.088
5.00	0.084
5.10	0.082

CURVE 81*
T = 2002

λ	ε
1.00	0.378
1.05	0.369
1.10	0.359
1.15	0.351
1.20	0.341
1.24	0.333
1.30	0.323
1.35	0.314
1.40	0.306
1.45	0.298
1.50	0.291
1.55	0.284
1.60	0.277
1.65	0.271
1.70	0.264
1.75	0.257
1.80	0.251
1.85	0.245
1.90	0.239
1.95	0.234
2.00	0.229
2.10	0.220
2.20	0.211
2.30	0.202
2.40	0.194
2.50	0.187
2.60	0.180
2.70	0.173
2.80	0.167
2.90	0.162
3.00	0.157

CURVE 81 (cont.)*
T = 2002

λ	ε
3.20	0.147
3.40	0.139
3.60	0.132
3.80	0.125
4.00	0.119
4.20	0.113
4.40	0.108
4.60	0.103
4.80	0.099
5.00	0.095
5.10	0.093

CURVE 82*
T = 2160

λ	ε
1.00	0.374
1.05	0.366
1.10	0.357
1.15	0.349
1.20	0.341
1.24	0.333
1.30	0.324
1.35	0.316
1.40	0.308
1.45	0.301
1.50	0.294
1.55	0.287
1.60	0.280
1.65	0.274
1.70	0.268
1.75	0.262
1.80	0.251
1.85	0.251
1.90	0.245
1.95	0.241
2.00	0.236
2.10	0.227
2.20	0.218
2.30	0.210
2.40	0.202
2.50	0.195
2.60	0.189
2.70	0.183
2.80	0.177
2.90	0.172

CURVE 82 (cont.)*
T = 2160

λ	ε
3.00	0.167
3.20	0.157
3.40	0.149
3.60	0.142
3.80	0.135
4.00	0.129
4.20	0.124
4.40	0.119
4.60	0.114
4.80	0.110
5.00	0.106
5.10	0.104

CURVE 83*
T = 2327

λ	ε
1.00	0.371
1.05	0.364
1.10	0.356
1.15	0.348
1.20	0.340
1.24	0.333
1.30	0.324
1.35	0.317
1.40	0.310
1.45	0.303
1.50	0.297
1.55	0.291
1.60	0.285
1.65	0.279
1.70	0.273
1.75	0.268
1.80	0.262
1.85	0.257
1.90	0.252
1.95	0.247
2.00	0.243
2.10	0.234
2.20	0.225
2.30	0.217
2.40	0.209
2.50	0.202
2.60	0.195
2.70	0.189
2.80	0.184

CURVE 83 (cont.)*
T = 2327

λ	ε
2.90	0.179
3.00	0.174
3.20	0.166
3.40	0.157
3.60	0.151
3.80	0.144
4.00	0.139
4.20	0.134
4.40	0.128
4.60	0.124
4.80	0.120
5.00	0.116
5.10	0.114

CURVE 84*
T = 2441

λ	ε
1.00	0.369
1.05	0.362
1.10	0.354
1.15	0.347
1.20	0.339
1.24	0.333
1.30	0.325
1.35	0.318
1.40	0.312
1.45	0.305
1.50	0.299
1.55	0.294
1.60	0.288
1.65	0.282
1.70	0.277
1.75	0.272
1.80	0.266
1.85	0.262
1.90	0.257
1.95	0.252
2.00	0.248
2.10	0.239
2.20	0.231
2.30	0.223
2.40	0.216
2.50	0.209
2.60	0.202
2.70	0.196

CURVE 84 (cont.)*
T = 2441

λ	ε
2.80	0.191
2.90	0.186
3.00	0.181
3.20	0.172
3.40	0.164
3.60	0.158
3.80	0.151
4.00	0.146
4.20	0.140
4.40	0.136
4.60	0.132
4.80	0.127
5.00	0.124
5.10	0.122

CURVE 85
T = 300

λ	ε
0.46	0.583
0.49	0.560
0.55	0.537
0.61	0.519
0.79	0.506
0.99	0.428
1.19	0.371
1.40	0.332
1.60	0.262
1.80	0.175
2.00	0.128

CURVE 86*
T = 1100

λ	ε
0.45	0.531
0.49	0.526
0.54	0.517
0.61	0.505
0.80	0.467
0.99	0.414
1.19	0.359
1.41	0.315
1.60	0.271
1.79	0.217
2.00	0.185

CURVE 87*
T = 1500

λ	ε
0.46	0.529
0.49	0.519
0.55	0.507
0.61	0.494
0.79	0.450
1.00	0.405
1.19	0.357
1.40	0.315
1.61	0.268
1.79	0.240
2.00	0.208

CURVE 88*
T = 2000

λ	ε
0.46	0.506
0.49	0.503
0.55	0.489
0.61	0.482
0.79	0.438
0.99	0.398
1.20	0.360
1.40	0.312
1.60	0.270
1.79	0.250
2.00	0.221

CURVE 89*
T = 2500

λ	ε
0.46	0.485
0.49	0.484
0.55	0.480
0.61	0.467
0.80	0.423
0.99	0.385
1.20	0.352
1.40	0.303
1.60	0.282
1.80	0.262
2.00	0.237

CURVE 90*
T = 2143

λ	ε
0.3478	0.485
0.3717	0.495
0.3956	0.493
0.4196	0.503
0.4435	0.470
0.4677	0.475
0.4916	0.463
0.5158	0.453
0.5400	0.438
0.5641	0.415

CURVE 91*
T = 1600

λ	ε
0.230	0.393
0.244	0.438
0.264	0.469
0.280	0.478
0.299	0.481
0.335	0.477
0.356	0.479
0.382	0.481
0.452	0.473
0.561	0.462
0.625	0.451
0.753	0.439
0.853	0.424
0.963	0.400
1.13	0.360
1.27	0.328
1.50	0.282
1.79	0.234
2.14	0.196
2.40	0.176
2.69	0.160

CURVE 92*
T = 1800

λ	ε
0.229	0.379
0.241	0.424
0.258	0.456
0.274	0.471
0.299	0.477
0.327	0.474

CURVE 92 (cont.)*
T = 1800

λ	ε
0.365	0.477
0.383	0.478
0.450	0.470
0.545	0.461
0.612	0.450
0.731	0.437
0.828	0.423
0.972	0.393
1.10	0.363
1.27	0.329
1.48	0.289
1.70	0.254
1.97	0.222
2.34	0.191
2.70	0.170

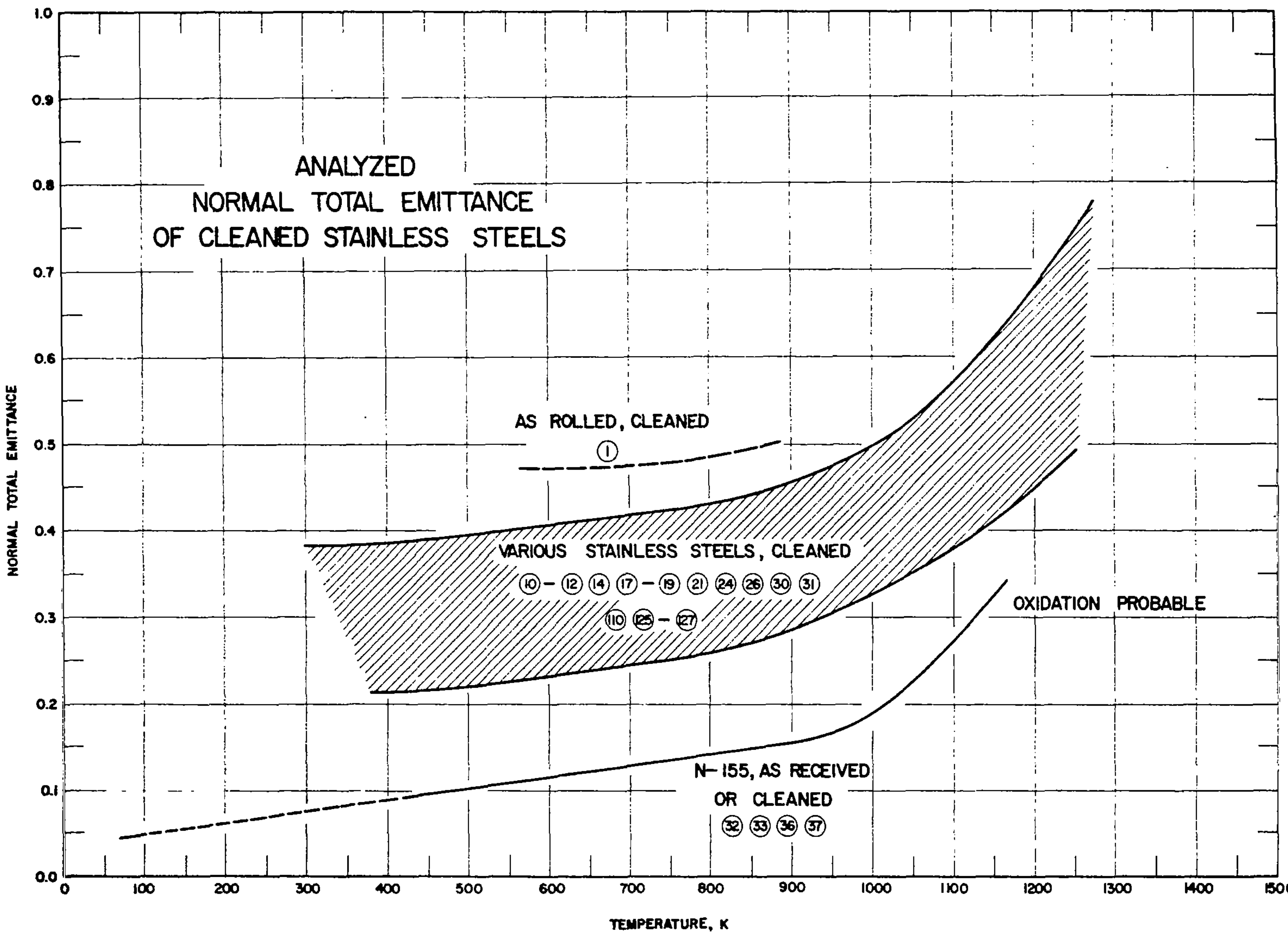
CURVE 93*
T = 2000

λ	ε
0.229	0.374
0.240	0.415
0.259	0.451
0.279	0.468
0.302	0.473
0.323	0.471
0.343	0.471
0.380	0.475
0.450	0.466
0.553	0.456
0.604	0.448
0.706	0.436
0.807	0.420
0.939	0.394
1.06	0.368
1.28	0.328
1.56	0.281
1.84	0.243
2.09	0.220
2.40	0.198
2.71	0.180

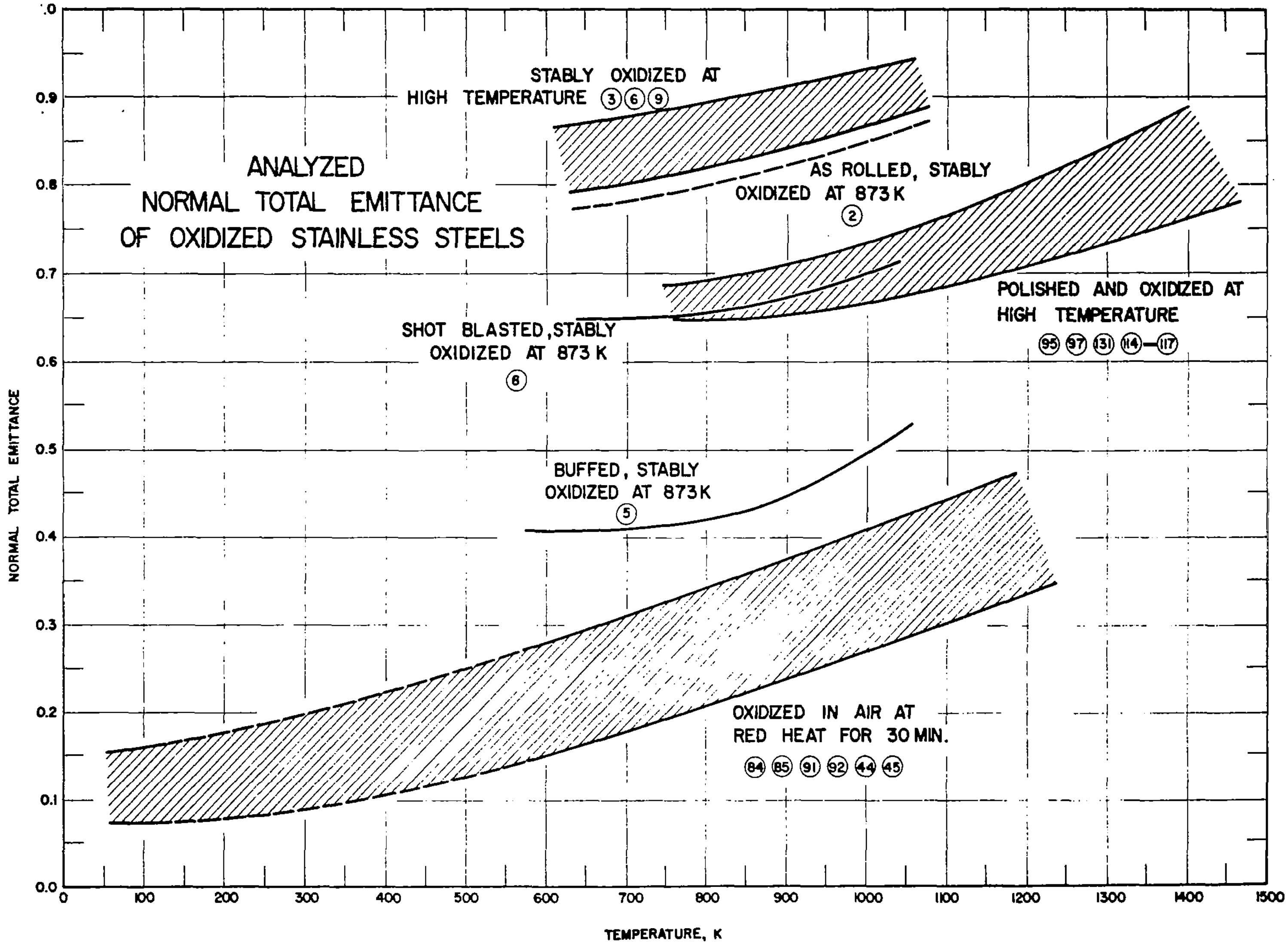
* Not shown on plot

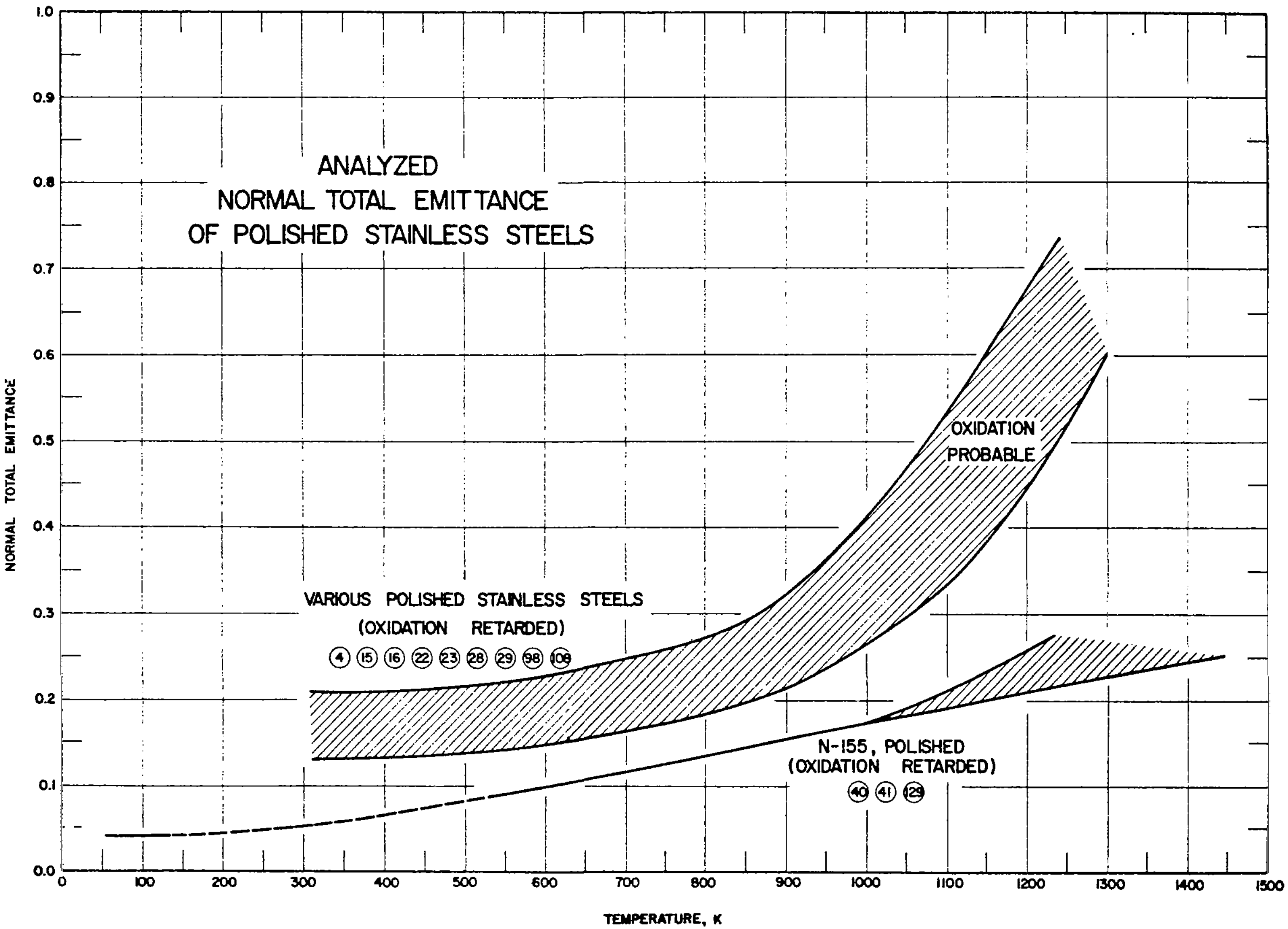
λ	ε	λ	ε
CURVE 94* T = 2200		CURVE 96* T = 2600	
0.231	0.364	0.231	0.363
0.247	0.427	0.241	0.400
0.264	0.452	0.260	0.437
0.285	0.466	0.283	0.454
0.306	0.469	0.301	0.460
0.331	0.467	0.340	0.462
0.375	0.471	0.377	0.465
0.451	0.463	0.419	0.460
0.553	0.453	0.502	0.450
0.604	0.444	0.567	0.443
0.704	0.432	0.654	0.430
0.807	0.414	0.756	0.413
0.918	0.392	0.883	0.390
1.27	0.329	1.04	0.364
1.60	0.279	1.27	0.328
2.00	0.236	1.60	0.289
2.40	0.206	2.00	0.250
2.68	0.191	2.41	0.224
		2.69	0.210
CURVE 95* T = 2400		CURVE 97* T = 2800	
0.231	0.363		
0.238	0.397	0.229	0.350
0.247	0.419	0.238	0.386
0.258	0.439	0.248	0.412
0.273	0.455	0.268	0.440
0.293	0.463	0.293	0.455
0.314	0.465	0.332	0.457
0.331	0.464	0.364	0.462
0.373	0.469	0.384	0.462
0.400	0.466	0.450	0.453
0.451	0.459	0.554	0.443
0.526	0.452	0.604	0.433
0.562	0.448	0.704	0.420
0.608	0.440	0.822	0.397
0.706	0.428	0.979	0.371
0.820	0.407	1.11	0.350
0.942	0.384	1.27	0.328
1.14	0.350	1.51	0.302
1.27	0.329	1.85	0.270
1.55	0.290	2.21	0.245
1.83	0.259	2.68	0.220
2.21	0.228		
2.68	0.201		

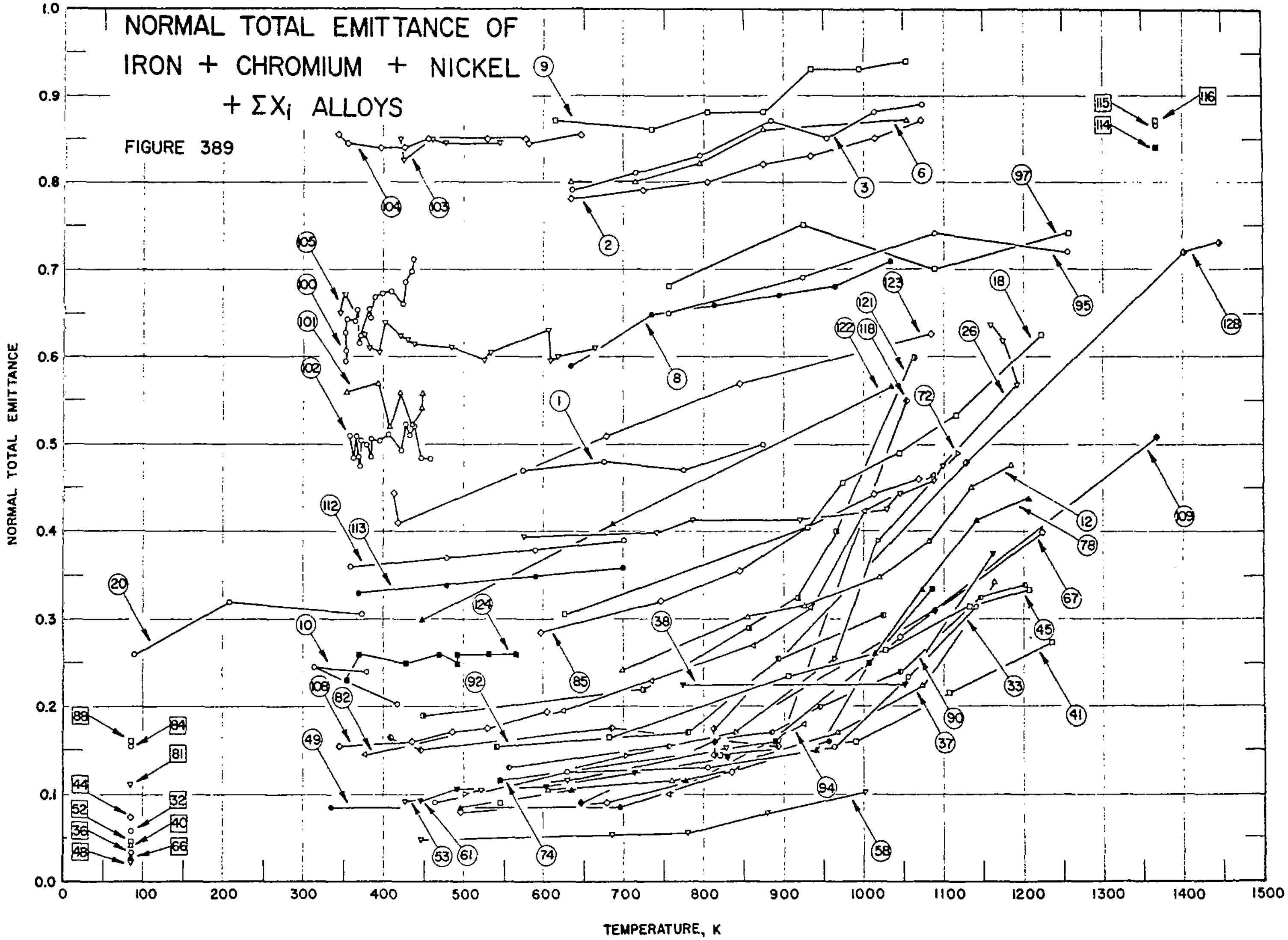
* Not shown on plot



ANALYZED
NORMAL TOTAL EMITTANCE
OF CLEANED STAINLESS STEELS
AS ROLLED, CLEANED
1
VARIOUS STAINLESS STEELS, CLEANED
10 – 12 14 17 – 19 21 24 26 30 31
110 125 – 127
OXIDATION PROBABLE
N–155, AS RECEIVED
OR CLEANED
32 33 36 37
NORMAL TOTAL EMITTANCE
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
TEMPERATURE, K


ANALYZED
NORMAL TOTAL EMITTANCE
OF OXIDIZED STAINLESS STEELS
STABLY OXIDIZED AT
HIGH TEMPERATURE 3 6 9
AS ROLLED, STABLY
OXIDIZED AT 873 K
2
POLISHED AND OXIDIZED AT
HIGH TEMPERATURE
95 97 131 114—117
SHOT BLASTED, STABLY
OXIDIZED AT 873 K
6
BUFFED, STABLY
OXIDIZED AT 873K
5
OXIDIZED IN AIR AT
RED HEAT FOR 30 MIN.
84 85 91 92 44 45
NORMAL TOTAL EMITTANCE
TEMPERATURE, K
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500


ANALYZED
NORMAL TOTAL EMITTANCE
OF POLISHED STAINLESS STEELS
VARIOUS POLISHED STAINLESS STEELS
(OXIDATION RETARDED)
4 15 16 22 23 28 29 98 108
OXIDATION
PROBABLE
N-155, POLISHED
(OXIDATION RETARDED)
40 41 129
NORMAL TOTAL EMITTANCE
TEMPERATURE, K
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500


NORMAL TOTAL EMITTANCE OF
IRON + CHROMIUM + NICKEL
+ ΣX_i ALLOYS
FIGURE 389
NORMAL TOTAL EMITTANCE
TEMPERATURE, K

SPECIFICATION TABLE NO. 389 NORMAL TOTAL EMITTANCE OF [IRON + CHROMIUM + NICKEL + ΣX_i] ALLOYS

Curve No.	Ref. No.	Year	Temperature Range, K	Geometry θ'	Reported Error, %	Composition (weight percent), Specifications and Remarks
1	68	1952	573-873	$\sim 0°$		Stainless steel Vickers F.D.P.; nominal composition: 18 Cr, 8 Ni, Fe balance; as rolled; cleaned with CCl_4; measured in air.
2	68	1952	633-1073	$\sim 0°$		Different sample, same as curve 1 specimen and conditions; oxidized at 873 K until steady state reached.
3	68	1952	633-1073	$\sim 0°$		Different sample, same as curve 1 specimen and conditions except oxidized at 1173 K until steady state reached.
4	68	1952	663-893	$\sim 0°$		Different sample, same as curve 1 specimen and conditions except buffed.
5	68	1952	573-1053	$\sim 0°$		Different sample, same as curve 4 specimen and conditions; oxidized at 873 K until steady state reached.
6	68	1952	633-1053	$\sim 0°$		Different sample, same as curve 4 specimen and conditions except oxidized at 1173 K until steady state reached.
7	68	1952	583-873	$\sim 0°$		Different sample, same as curve 1 specimen and conditions except shot blasted with fused alumina.
8	68	1952	633-1033	$\sim 0°$		Different sample, same as curve 7 specimen and conditions; oxidized at 873 K until steady state reached.
9	68	1952	613-1053	$\sim 0°$		Different sample, same as curve 7 specimen and conditions except oxidized at 1173 K until steady state reached.
10	160	1954	377-414	$\sim 0°$		Stainless steel 301; nominal composition: 16.00-18.00 Cr, 6.00-8.00 Ni, 2.00 max Mn, 1.00 max Si, 0.15 max C, Fe balance; cleaned with methyl alcohol; measured in vacuum (10^{-3} mm Hg); [Author's designation: Sample 6].
11	160	1954	505-1280	$\sim 0°$		Different sample, same as above specimen and conditions except measured in argon (10^{-3} mm Hg); [Author's designation: Sample 11].
12	160	1954	697-1183	$\sim 0°$		Above specimen and conditions.
13	160	1954	88.9-364	$\sim 0°$		Different sample, same as curve 10 specimen and conditions except scrubbed with Bon Ami on a wet cloth, washed and dried, wiped with tolvene and alcohol; [Author's designation: Sample 2].
14	160	1954	439-1347	$\sim 0°$		Different sample, same as above specimen and conditions except measured in argon (10^{-3} mm Hg); heating and cooling; [Author's designation: Sample 12].
15	160	1954	305-412	$\sim 0°$		Different sample, same as curve 10 specimen and conditions except polished, then finished with a wool buff and rouge and washed; surface free from scratches; [Author's designation: Sample 4].
16	160	1954	469-1258	$\sim 0°$		Different sample, same as above specimen and conditions except measured in argon (10^{-3}mm Hg); [Author's designation: Sample 13].
17	160	1954	310-423	$\sim 0°$		Stainless steel 316; nominal composition: 16.00-18.00 Cr, 10.00-14.00 Ni, 2.00-3.00 Mo, 2.00 max Mn, 1.00 max Si, 0.08 max C; cleaned with methyl alcohol; measured in vacuum (10^{-3} mm Hg); heating; [Author's designation: Sample 1].

SPECIFICATION TABLE NO. 389 (continued)

Curve No.	Ref. No.	Year	Temperature Range, K	Geometry θ'	Reported Error, %	Composition (weight percent), Specifications and Remarks
18	160	1954	623-1221	~0°		Different sample, same as above specimen and conditions except measured in argon (10^{-3} mm Hg); [Author's designation: Sample 10].
19	160	1954	496-1219	~0°		Above specimen and conditions.
20	160	1954	88.9-372	~0°		Different sample, same as curve 17 specimen and conditions except scrubbed with Bon Ami on a wet cloth, washed and dried, wiped with toluene and alcohol; [Author's designation, Sample 2].
21	160	1954	517-1402	~0°		Different sample, same as above specimen and conditions except measured in argon (10^{-3} mm Hg); [Author's designation: Sample 11].
22	160	1954	314-432	~0°		Different sample, same as curve 17 specimen and conditions except polished and then finished with a wool buff and rouge and washed; surface free from scratches; [Author's designation: Sample 3].
23	160	1954	281-1417	~0°		Different sample, same as above specimen and conditions except measured in argon (10^{-3} mm Hg); [Author's designation: Sample 12].
24	160	1954	318-423	~0°		Stainless steel 347; nominal composition: 17.00-19.00 Cr, 9.00-13.00 Ni, 2.00 max Mn, 1.00 max Si, 0.08 max C, 10 x C min Nb-Ta, Fe balance; cleaned with methyl alcohol; measured in vacuum (10^{-3} mm Hg); heating; [Author's designation: Sample 7].
25	160	1954	319-423	~0°		Different sample, same as curve 24 specimen and conditions; [Author's designation: Sample 13].
26	160	1954	574-1191	~0°		Different sample, same as curve 24 specimen and conditions except measured in argon (10^{-3} mm Hg); [Author's designation: Sample 12].
27	160	1954	474-1192	~0°		Above specimen and conditions except heating and cooling.
28	160	1954	303-426	~0°		Different sample, same as curve 24 specimen and conditions except polished and then finished with a wool buff and rouge and washed; surface free from scratches; [Author's designation: Sample 6].
29	160	1954	488-1294	~0°		Different sample, same as curve 28 specimen and conditions except measured in argon (10^{-3} mm Hg); [Author's designation: Sample 15].
30	160	1954	303-434	~0°		Different sample, same as curve 24 specimen and conditions except scrubbed with Bon Ami on a wet cloth, washed and dried, wiped with toluene and alcohol; [Author's designation: Sample 5].
31	160	1954	493-1267	~0°		Different sample, same as curve 30 specimen and conditions except measured in argon (10^{-3} mm Hg); [Author's designation: Sample 14].
32	34	1957	83.2	~0°	± 10	Cobalt alloy N-155; nominal composition: 21 Cr, 20 Co, 20 Ni, 3 Mo, 3 W, 1.5 Mn, 1 Nb, 0.5 Si, 0.15 C, 0.15 N, Fe balance; as received; measured in vacuum (5 x 10^{-4} mm Hg).
33	34	1957	461-1139	~0°	± 10	Different sample, same as above specimen and conditions; increasing temp, cycle 1.
34	34	1957	533-850	~0°	± 10	Above specimen and conditions; cycle 2.

Curve No.	Ref. No.	Year	Temperature Range, K	Geometry θ'	Reported Error, %	Composition (weight percent), Specifications and Remarks
35	34	1957	522	~0°	± 10	Above specimen and conditions; cycle 3.
36	34	1957	83.2	~0°	± 10	Different sample, same as curve 32 specimen and conditions except cleaned with liquid detergent.
37	34	1957	603-1161	~0°	± 10	Different sample, same as above specimen and conditions; increasing temp, cycle 1.
38	34	1957	772-1161	~0°	± 10	Above specimen and conditions; cycle 2.
39	34	1957	800-1003	~0°	± 10	Above specimen and conditions; cycle 3.
40	34	1957	83.2	~0°	± 10	Different sample, same as curve 32 specimen and conditions except polished.
41	34	1957	544-1233	~0°	± 10	Different sample, same as above specimen and conditions; increasing temp, cycle 1.
42	34	1957	811-989	~0°	± 10	Above specimen and conditions; cycle 2.
43	34	1957	911-1108	~0°	± 10	Above specimen and conditions; cycle 3.
44	34	1957	83.2	~0°	± 10	Different sample, same as curve 32 specimen and conditions except oxidized in air at red heat for 30 min.
45	34	1957	680-1205	~0°	± 10	Different sample, same as above specimen and conditions; increasing temp, cycle 1.
46	34	1957	769-911	~0°	± 10	Above specimen and conditions; cycle 2.
47	34	1957	611-1289	~0°	± 10	Above specimen and conditions; cycle 3.
48	34	1957	83.2	~0°	± 10	Stainless steel type PH 15-7 Mo; nominal composition: 15 Cr, 7 Ni, 2.25 Mo, 1.15 Al, 0.70 Mn, 0.40 Si, 0.07 C, Fe balance; surface roughness ~2 microinches rms; measured in vacuum (5 x 10^{-4} mm Hg).
49	34	1957	333-955	~0°	± 10	Different sample, same as above specimen and conditions; increasing temp, cycle 1.
50	34	1957	661-866	~0°	± 10	Above specimen and conditions; cycle 2.
51	34	1957	511-950	~0°	± 10	Above specimen and conditions; cycle 3.
52	34	1957	83.2	~0°	± 10	Different sample, same as curve 48 specimen and conditions; surface roughness ~15 microinches.
53	34	1957	425-828	~0°	± 10	Different sample, same as above specimen and conditions; increasing temp, cycle 1.
54	34	1957	483-878	~0°	± 10	Above specimen and conditions; cycle 2.
55	34	1957	625-844	~0°	± 10	Above specimen and conditions; cycle 3.
56	34	1957	83.2	~0°	± 10	Stainless steel type 17-7 PH; nominal composition: 17 Cr, 7 Ni, 1.15 Al, 0.70 Mn, 0.40 Si, 0.07 C, Fe balance; surface roughness ~2 microinches rms; measured in vacuum (5 x 10^{-4} mm Hg).
57	34	1957	472-755	~0°	± 10	Different sample, same as above specimen and conditions except increasing temp, cycle 1.
58	34	1957	444-1000	~0°	± 10	Above specimen and conditions; cycle 2.
59	34	1957	650-933	~0°	± 10	Above specimen and conditions; cycle 3.

SPECIFICATION TABLE NO. 389 (continued)

Curve No.	Ref. No.	Year	Temperature Range, K	Geometry θ'	Reported Error, %	Composition (weight percent), Specifications and Remarks
60	34	1957	83.2	~0°	± 10	Different sample, same as curve 56 specimen and conditions; surface roughness ~15 microinches rms.
61	34	1957	444-828	~0°	± 10	Different sample, same as above specimen and conditions except increasing temp, cycle 1.
62	34	1957	661-1053	~0°	± 10	Above specimen and conditions; cycle 2.
63	34	1957	605	~0°	± 10	Above specimen and conditions; decreasing temp, cycle 2.
64	34	1957	478-722	~0°	± 10	Above specimen and conditions; cycle 3.
65	34	1957	616	~0°	± 10	Above specimen and conditions; decreasing temp, cycle 3.
66	34	1957	83.2	~0°	± 10	Stainless steel type 316; nominal composition: 16.00-18.00 Cr, 10.00-14.00 Ni, 2.00-3.00 Mo, 2.00 max Mn, 1.00 max Si, 0.08 max C, Fe balance; surface roughness ~2 microinches rms; measured in vacuum (5×10^{-4} mm Hg).
67	34	1957	494-1222	~0°	± 10	Different sample, same as above specimen and conditions except increasing temp, cycle 1.
68	34	1957	505-1039	~0°	± 10	Above specimen and conditions; cycle 2.
69	34	1957	83.2	~0°	± 10	Different sample, same as curve 66 specimen and conditions; surface roughness ~15 microinches rms.
70	34	1957	444-628	~0°	± 10	Different sample, same as above specimen and conditions except increasing temp, cycle 1.
71	34	1957	466-855	~0°	± 10	Above specimen and conditions; cycle 2.
72	34	1957	500-1116	~0°	± 10	Above specimen and conditions; cycle 3.
73	34	1957	83.2	~0°	± 10	Stainless steel type 321; nominal composition: 17.00-19.00 Cr, 9.00-12.00 Ni, 2.00 max Mn, 1.00 max Si, 0.08 max C, 5 x C min Ti, Fe balance; bright finish; measured in vacuum (5×10^{-4} mm Hg).
74	34	1957	544-1083	~0°	± 10	Different sample, same as above specimen and conditions except increasing temp, cycle 1.
75	34	1957	622-894	~0°	± 10	Above specimen and conditions; cycle 2.
76	34	1957	872-1122	~0°	± 10	Above specimen and conditions; cycle 3.
77	34	1957	83.2	~0°	± 10	Different sample, same as curve 73 specimen and conditions; surface roughness ~2 microinches rms.
78	34	1957	494-1205	~0°	± 10	Different sample, same as above specimen and conditions except increasing temp, cycle 1.
79	34	1957	633-994	~0°	± 10	Above specimen and conditions; cycle 2.
80	34	1957	728-1061	~0°	± 10	Above specimen and conditions; cycle 3.
81	34	1957	83.2	~0°	± 10	Different sample, same as curve 73 specimen and conditions except dull finish; surface roughness ~6 microinches rms.
82	34	1957	375-1089	~0°	± 10	Different sample, same as above specimen and conditions.
83	34	1957	561-761	~0°	± 10	Above specimen and conditions; cycle 2.

Curve No.	Ref. No.	Year	Temperature Range, K	Geometry θ'	Reported Error, %	Composition (weight percent), Specifications and Remarks
84	34	1957	83.2	$\sim 0°$	± 10	Different sample, same as curve 73 specimen and conditions except oxidized in air at red heat for 30 min; surface roughness ~6 microinches rms.
85	34	1957	594-1069	$\sim 0°$	± 10	Different sample, same as above specimen and conditions except increasing temp. cycle 1.
86	34	1957	544-789	$\sim 0°$	± 10	Above specimen and conditions; cycle 2.
87	34	1957	950	$\sim 0°$	± 10	Above specimen and conditions; cycle 3.
88	34	1957	83.2	$\sim 0°$	± 10	Stainless steel type AM 350; nominal composition: 16.50 Cr, 4.25 Ni, 2.75 Mo, 0.75 Mn, 0.35 Si, 0.10 C, 0.10 N, Fe balance; surface roughness ~2 microinches rms; measured in vacuum (5×10^{-4} mm Hg).
89	34	1957	422-605	$\sim 0°$	± 10	Different sample, same as above specimen and conditions except increasing temp. cycle 1.
90	34	1957	553-1200	$\sim 0°$	± 10	Above specimen and conditions; cycle 2.
91	34	1957	83.2	$\sim 0°$	± 10	Different sample, same as curve 88 specimen and conditions except oxidized in air at red heat for 30 min.
92	34	1957	539-1022	$\sim 0°$	± 10	Different sample, same as above specimen and conditions except increasing temp. cycle 1.
93	34	1957	900-1161	$\sim 0°$	± 10	Above specimen and conditions; cycle 2.
94	170	1959	755-922	$\sim 0°$		Stainless steel 321; titanium stabilized 18 Cr, 8 Ni austenitic stainless steel; electropolished; computed from spectral data.
95	170	1959	755-1255	$\sim 0°$		Different sample, same as curve 94 specimen and conditions except also oxidized in air at 1255 K for 1/2 hr.
96	170	1959	755-922	$\sim 0°$		Different sample, same as curve 94 specimen and conditions except sandblasted by 40-mesh glass sand and air at 40 psi.
97	170	1959	755-1255	$\sim 0°$		Different sample, same as curve 94 specimen and conditions except also oxidized in air at 1255 K for 1/2 hr.
98	15	1947	373	$\sim 0°$		Alleghany metal; nominal composition: 17-20 Cr, 7-10 Ni, 0.50 max Mn, 0.20 C, Fe balance; No. 4 polish.
99	157	1944	356-441	$\sim 0°$		Stainless steel 18-8; nominal composition: 18.45 Cr, 8.79 Ni, 0.50 Mn, 0.10 C, Fe balance; oxidized at 811 K; measured in air.
100	157	1944	350-435	$\sim 0°$		Different sample, same as curve 99 specimen and conditions except oxidized at 1089 K.
101	157	1944	351-446	$\sim 0°$		Different sample, same as curve 99 specimen and conditions except chromic and sulfuric blackened.
102	157	1944	355-456	$\sim 0°$		Different sample, same as curve 99 specimen and conditions except sand blasted.
103	155	1948	419-594	$\sim 0°$		Stainless steel 18-8; nominal composition: 18.45 Cr, 8.79 Ni, 0.50 Mn, 0.10 C, Fe balance; sand blasted and weathered.
104	155	1948	342-646	$\sim 0°$		Different sample, same as curve 103 specimen and conditions except oxidized at 1089 K and weathered.

Curve No.	Ref. No.	Year	Temperature Range, K	Geometry θ'	Reported Error, %	Composition (weight percent), Specifications and Remarks
105	155	1948	344-661	~0°		Different sample, same as curve 103 specimen and conditions except chromic and sulphuric acid treated and weathered.
106	155	1948	455-650	~0°		Different sample, same as curve 103 specimen and conditions except unpolished.
107	155	1948	353-655	~0°		Different sample, same as curve 103 specimen and conditions.
108	155	1948	344-603	~0°		Above specimen and conditions except polished with Aerobright and Bon Ami.
109	107	1960	644-1644	~0°	± 20	Stainless steel 301; nominal composition: 16.00-18.00 Cr, 6.00-8.00 Ni, 2.00 Mn, 1.00 max Si, 0.15 max C, Fe balance; measured in demoisturized helium gas.
110	99	1958	366-699	~0°	< 9	Type 321 corrosion-resistant steel; MIL-S-6721; nominal composition: 17.00-19.00 Cr, 9.00-12.00 Ni, 2.00 max Mn, 1.00 max Si, 0.08 max C, 5 x C min Ti, Fe balance; measured in air.
111	99	1958	366-699	~0°	< 9	Different sample, same as curve 110 specimen and conditions except heated at 647 K for 1000 hrs.
112	99	1958	366-699	~0°		Different sample, same as curve 110 specimen and conditions except calculated from spectral β (2π,0°).
113	99	1958	366-699	~0°		Different sample, same as curve 112 specimen and conditions except heated at 647 K for 1000 hrs.
114	164	1961	1366	~0°	± 2.5	Stainless steel type 303; nominal composition: 17.00-19.00 Cr, 8.00-10.00 Ni, 2.00 max Mn, 1.00 max Si, 0.15 min S, 0.15 max C, Fe balance; mechanically polished and cleaned; oxidized in quiescent air at 1366 K for 10 min; measured in air.
115	164	1961	1366	~0°	± 2.5	Above specimen and conditions except oxidized in quiescent air at 1366 K for 25 min.
116	164	1961	1366	~0°	± 2.5	Above specimen and conditions except oxidized in quiescent air at 1366 K for 40 min.
117	164	1961	1366	~0°	± 2.5	Above specimen and conditions except oxidized in quiescent air at 1366 K for 70 min.
118	40	1962	408-1061	~0°		Cobalt alloy N-155 (surface N-1); nominal composition: 21 Cr, 20 Co, 20 Ni, 3 Mo, 3 W, 1.5 Mn, 1 Nb, 0.5 Si, 0.15 C, 0.15 N, Fe balance; as received; increasing temp.
119	40	1962	408-655	~0°		Above specimen and conditions; decreasing temp.
120	40	1962	367	~0°		Different sample, same as curve 118 specimen and conditions except highly polished, mirror finish; oxide formation at 873 K for 3 hrs.
121	40	1962	447-1061	~0°		Different sample, same as curve 118 specimen and conditions except surface N-2; increasing temp.
122	40	1962	1033-447	~0°		Above specimen and conditions; decreasing temp.
123	40	1962	411-1084	~0°		Different sample, same as curve 121 specimen and conditions except heat treated; same results for increasing and decreasing temp.
124	40	1962	352-564	~0°		Poroloy (18-8 stainless steel); nominal composition: 18.45 Cr, 8.79 Ni, 0.50 Mn, 0.10 C, Fe balance; porosity between 28 and 31%.

SPECIFICATION TABLE NO. 389 (continued)

Curve No.	Ref. No.	Year	Temperature Range, K	Geometry θ'	Reported Error, %	Composition (weight percent), Specifications and Remarks
125	40	1962	367	$\sim 0°$		Different sample, same as above specimen and conditions except porosity 28%.
126	40	1962	367	$\sim 0°$		Different sample, same as above specimen and conditions except porosity 31%.
127	40	1962	367	$\sim 0°$		Different sample, same as above specimen and conditions except porosity 43%.
128	75	1962	811-1444	$\sim 0°$		Stainless steel 304; nominal composition: 18.00-20.00 Cr, 8.00-12.00 Ni, 2.00 max Mn, 1.00 max Si, 0.08 max C, Fe balance; machine finished; helium purge.
129	92	1963	1328-1466	$\sim 0°$		Haynes Alloy N-155 (Multimet); 23.98-36.15 Fe, 19-21 Ni, 18.5-21 Co, 20-22.5 Cr, 2-3 W, 0.75-1.25 Nb and Ta, 2.5-3.5 Mo, 1.0-2.0 Mn, 0.5 max Cu, 1.0 max Si, 0.03 max S, 0.04 max P, 0.1-0.2 N_2, 0.08-0.16 C; polished; surface roughness 1 to 2 μ (RMS) measured with profilometer; measured in vacuum (3 to 4 x 10^{-4} mm Hg); 1st cycle.
130	92	1963	1289-1600	$\sim 0°$		Above specimen and conditions; 2nd cycle.
131	92	1963	1239-1452	$\sim 0°$		Curve 129 specimen and conditions except oxidized.
132	273	1962	805-1442	$\sim 0°$		Stainless steel 304; nominal composition: 18.00-20.00 Cr, 8.00-12.00 Ni, 2.00 max Mn, 1.00 max Si, 0.08 max C, Fe balance; mechanical finish; measured in He gas.

DATA TABLE NO. 389 NORMAL TOTAL EMITTANCE OF [IRON + CHROMIUM + NICKEL + ΣX_i] ALLOYS

[Temperature, T, K; Emittance, ϵ]

T	ϵ
CURVE 1	
573	0.47
673	0.48
773	0.47
873	0.50
CURVE 2	
633	0.77
723	0.79
803	0.80
873	0.82
933	0.83
1013	0.85
1073	0.87
CURVE 3	
633	0.79
713	0.81
793	0.83
883	0.87
953	0.85
1013	0.88
1073	0.89
CURVE 4*	
663	0.22
733	0.24
783	0.26
853	0.28
893	0.28
CURVE 5*	
573	0.42
653	0.40
763	0.42
853	0.42
933	0.46
993	0.50
1053	0.52
CURVE 6	
633	0.85
713	0.85
793	0.87
873	0.86
1053	0.87
CURVE 7*	
583	0.40
683	0.43
733	0.44
783	0.45
833	0.47
873	0.49
CURVE 8	
633	0.59
733	0.65
813	0.66
893	0.67
963	0.68
1033	0.71
CURVE 9	
613	0.87
733	0.86
803	0.88
873	0.88
933	0.93
993	0.93
1053	0.94
CURVE 10	
414	0.202
312	0.246
377	0.240
CURVE 11*	
531	0.223
1242	0.487
1239	0.603
CURVE 11* (cont.)	
1280	0.577
507	0.557
1218	0.547
505	0.573
CURVE 12	
697	0.241
852	0.301
924	0.315
1018	0.344
1080	0.389
1133	0.451
1183	0.477
CURVE 13*	
88.9	0.245
214	0.260
364	0.275
CURVE 14*	
464	0.300
706	0.270
872	0.320
947	0.345
1114	0.460
1197	0.580
1247	0.620
1347	0.370
556	0.230
1206	0.460
1139	0.525
1189	0.580
1172	0.690
439	0.440
488	0.400
1222	0.630
547	0.540
CURVE 15*	
412	0.100
305	0.145
390	0.203
CURVE 16*	
526	0.233
707	0.212
908	0.261
1067	0.466
1128	0.536
1186	0.640
1239	0.729
1258	0.675
469	0.427
1178	0.708
485	0.549
1185	0.699
483	0.502
CURVE 17*	
423	0.247
310	0.280
364	0.285
CURVE 18	
623	0.306
929	0.405
971	0.457
1043	0.490
1114	0.532
1221	0.626
CURVE 19*	
496	0.329
786	0.319
1164	0.585
1219	0.674
510	0.572
1132	0.663
504	0.581
CURVE 20	
88.9	0.260
206	0.320
372	0.305
CURVE 21*	
538	0.314
792	0.312
929	0.330
1051	0.396
1160	0.559
1217	0.663
1282	0.777
1321	0.657
1397	0.431
1402	0.362
523	0.331
1164	0.410
1329	0.552
1350	0.510
533	0.529
1329	0.504
517	0.517
CURVE 22*	
432	0.169
314	0.196
371	0.176
CURVE 23*	
679	0.174
893	0.203
1029	0.283
1127	0.362
1169	0.431
1214	0.594
1280	0.629
1300	0.597
1417	0.320
502	0.226
1147	0.282
1327	0.316
281	0.262
CURVE 24*	
423	0.368
318	0.394
360	0.368
CURVE 25*	
423	0.424
319	0.463
359	0.424
CURVE 26	
574	0.394
739	0.398
785	0.414
919	0.413
1029	0.426
1045	0.444
1088	0.458
1098	0.474
1191	0.568
1173	0.620
1159	0.639
CURVE 27*	
525	0.394
1192	0.495
1159	0.637
482	0.493
1177	0.650
474	0.516
CURVE 28*	
426	0.150
303	0.169
370	0.173
CURVE 29*	
532	0.211
719	0.217
919	0.232
1046	0.281
1170	0.412
1232	0.553
1290	0.624
1294	0.656
488	0.388
1175	0.607
537	0.488
CURVE 29* (cont.)	
1183	0.636
547	0.497
CURVE 30*	
434	0.324
303	0.381
368	0.336
CURVE 31*	
493	0.367
661	0.385
923	0.437
1017	0.475
1111	0.629
1194	0.696
1247	0.717
1267	0.705
525	0.561
548	0.485
1151	0.654
550	0.521
CURVE 32	
83.2	0.058
CURVE 33	
461	0.090
628	0.125
803	0.130
961	0.155
1055	0.235
1139	0.315
CURVE 34*	
533	0.150
850	0.125
CURVE 35*	
522	0.140
CURVE 36	
83.2	0.033
CURVE 37	
603	0.105
758	0.115
966	0.170
1072	0.225
1161	0.345
CURVE 38	
772	0.225
1050	0.225
1161	0.375
CURVE 39*	
800	0.270
1003	0.325
CURVE 40	
83.2	0.041
CURVE 41	
544	0.090
819	0.145
989	0.160
1105	0.215
1233	0.275
CURVE 42*	
811	0.190
989	0.240
CURVE 43*	
911	0.230
1108	0.280
CURVE 44	
83.2	0.072

* Not shown on plot

DATA TABLE NO. 389 (continued)

CURVE 45

T	∈
680	0.165
905	0.235
1025	0.265
1130	0.315
1205	0.335

CURVE 46*

T	∈
769	0.220
911	0.265

CURVE 47*

T	∈
611	0.150
1289	0.280

CURVE 48

T	∈
83.2	0.022

CURVE 49

T	∈
333	0.085
694	0.085
955	0.160

CURVE 50*

T	∈
661	0.090
866	0.115

CURVE 51*

T	∈
511	0.080
678	0.100
950	0.140

CURVE 52

T	∈
83.2	0.044

CURVE 53

T	∈
425	0.091
519	0.103
628	0.116
828	0.152

CURVE 54*

T	∈
483	0.082
616	0.103
733	0.132
816	0.153
878	0.172

CURVE 55*

T	∈
625	0.131
844	0.196

CURVE 56*

T	∈
83.2	0.022

CURVE 57*

T	∈
472	0.046
666	0.053
755	0.057

CURVE 58

T	∈
444	0.049
683	0.053
778	0.056
878	0.079
1000	0.101

CURVE 59*

T	∈
650	0.052
933	0.086

CURVE 60*

T	∈
83.2	0.044

CURVE 61

T	∈
444	0.093
489	0.105
600	0.106
711	0.123
828	0.143

CURVE 62*

T	∈
661	0.106
939	0.154
1053	0.147

CURVE 63*

T	∈
605	0.103

CURVE 64*

T	∈
478	0.103
722	0.126

CURVE 65*

T	∈
616	0.101

CURVE 66

T	∈
83.2	0.027

CURVE 67

T	∈
494	0.080
678	0.090
833	0.125
1044	0.280
1222	0.400

CURVE 68*

T	∈
505	0.090
666	0.100
772	0.095
1039	0.300

CURVE 69*

T	∈
83.2	0.045

CURVE 70*

T	∈
444	0.100
628	0.120

CURVE 71*

T	∈
466	0.100
661	0.120
761	0.145
855	0.170

CURVE 72*

T	∈
500	0.100
700	0.145
839	0.170
961	0.255
1016	0.390
1116	0.490

CURVE 73*

T	∈
83.2	0.044

CURVE 74

T	∈
544	0.115
889	0.160
1005	0.250
1083	0.335

CURVE 75*

T	∈
622	0.165
894	0.275

CURVE 76*

T	∈
872	0.275
1044	0.350
1122	0.420

CURVE 77*

T	∈
83.2	0.036

CURVE 78

T	∈
494	0.085
633	0.105
775	0.115
939	0.150
1011	0.260
1072	0.335
1139	0.415
1205	0.440

CURVE 79*

T	∈
633	0.280
844	0.345
955	0.360
994	0.390

CURVE 80*

T	∈
728	0.320
1061	0.425

CURVE 81

T	∈
83.2	0.111

CURVE 82

T	∈
375	0.145
622	0.195
733	0.230
861	0.270
933	0.315
1000	0.423
1089	0.465

CURVE 83*

T	∈
561	0.260
761	0.345

CURVE 84

T	∈
83.2	0.155

CURVE 85

T	∈
594	0.285
744	0.320
844	0.355
930	0.405*
1011	0.445
1069	0.460

CURVE 86*

T	∈
544	0.300
789	0.360

CURVE 87*

T	∈
950	0.420

CURVE 88

T	∈
83.2	0.161

CURVE 89*

T	∈
422	0.110
605	0.125

CURVE 90

T	∈
553	0.130
755	0.155
883	0.170
941	0.200
1044	0.240
1144	0.325
1200	0.340

CURVE 91*

T	∈
83.2	0.111

CURVE 92

T	∈
539	0.155
778	0.170
891	0.255
1022	0.305

CURVE 93*

T	∈
900	0.290
1005	0.345
1161	0.390

CURVE 94

T	∈
755	0.10
922	0.18

CURVE 95

T	∈
755	0.65
922	0.69
1089	0.74
1255	0.72

CURVE 96*

T	∈
755	0.34
922	0.38

CURVE 97

T	∈
755	0.68
922	0.75
1089	0.70
1255	0.74

CURVE 98*

T	∈
373	0.13

CURVE 99*

T	∈
356	0.312
357	0.328
359	0.314

CURVE 99* (cont.)

T	∈
394	0.340
395	0.348
396	0.354
405	0.347
406	0.348
407	0.358
421	0.346
422	0.341
423	0.358
436	0.348
436	0.356
438	0.364
440	0.366
441	0.366

CURVE 100

T	∈
350	0.628
351	0.606
351	0.594
352	0.644
353	0.644*
364	0.642
365	0.654
365	0.656*
367	0.616
369	0.624
372	0.624*
373	0.628*
380	0.654
382	0.645
386	0.668
396	0.672
398	0.670*
406	0.674
410	0.676*
422	0.660
423	0.654*
424	0.686
432	0.698
435	0.712

* Not shown on plot

CURVE 101

T	ε
351	0.560
391	0.570
405	0.522
418	0.560
433	0.524
445	0.542
446	0.560

CURVE 102

T	ε
355	0.510
360	0.484
364	0.510
366	0.486
369	0.476
370	0.504
377	0.500
383	0.486
383	0.508
393	0.504
395	0.506*
404	0.511
419	0.492
425	0.524
429	0.510
435	0.522
438	0.518*
444	0.484
456	0.484

CURVE 103

T	ε
419	0.850
422	0.825
458	0.850
475	0.845
594	0.845

CURVE 104

T	ε
342	0.855
353	0.845
394	0.840
425	0.840
453	0.850

CURVE 104 (cont.)

T	ε
528	0.850
577	0.850
579	0.845
646	0.855

CURVE 105

T	ε
344	0.650
350	0.670
375	0.625
380	0.610
392	0.605
397	0.610*
400	0.640
419	0.625
428	0.620
433	0.620*
436	0.615
442	0.615*
483	0.610
525	0.595
533	0.605
605	0.630
608	0.595
617	0.600
661	0.610

CURVE 106*

T	ε
455	0.205
472	0.170
542	0.225
550	0.204
583	0.210
594	0.230
632	0.220
650	0.225

CURVE 107*

T	ε
353	0.180
380	0.170
414	0.180
503	0.190
539	0.195

CURVE 107* (cont.)

T	ε
563	0.203
592	0.200
611	0.210
655	0.205

CURVE 108

T	ε
344	0.155
433	0.160
483	0.170
528	0.175
603	0.195

CURVE 109

T	ε
644	0.09
811	0.16
1089	0.31
1367	0.51
1644	0.72*

CURVE 110*

T	ε
366	0.31
477	0.31
588	0.31
699	0.33

CURVE 111*

T	ε
366	0.31
477	0.33
588	0.31
699	0.33

CURVE 112

T	ε
366	0.36
477	0.37
588	0.38
699	0.39

CURVE 113

T	ε
366	0.33
477	0.34
588	0.35
699	0.36

CURVE 114

T	ε
1366	0.841

CURVE 115

T	ε
1366	0.867

CURVE 116

T	ε
1366	0.870

CURVE 117*

T	ε
1366	0.874

CURVE 118

T	ε
408	0.165
444	0.150
683	0.175
891	0.155
1061	0.550

CURVE 119*

T	ε
408	0.225
655	0.338

CURVE 120*

T	ε
367	0.16

CURVE 121

T	ε
447	0.190
722	0.220
855	0.290
916	0.325
964	0.400
1061	0.600

CURVE 122

T	ε
1033	0.566
683	0.410
447	0.300

CURVE 123

T	ε
411	0.445
416	0.410
677	0.510
844	0.570
1084	0.628

CURVE 124

T	ε
352	0.23
358	0.26
425	0.25
425	0.26*
469	0.26
489	0.25
490	0.26
491	0.26*
530	0.26
564	0.26

CURVE 125*

T	ε
367	0.23

CURVE 126*

T	ε
367	0.23

CURVE 127*

T	ε
367	0.32

CURVE 128

T	ε
811	0.145
811	0.175
1128	0.480
1400	0.720
1444	0.730

CURVE 129*

T	ε
1328	0.230
1369	0.250
1466	0.245

CURVE 130*

T	ε
1289	0.205
1354	0.220
1392	0.220
1490	0.240
1549	0.250*
1575	0.270*
1600	0.290*

CURVE 131*

T	ε
1239	0.720
1255	0.730
1311	0.760
1355	0.780
1452	0.700

CURVE 132*

T	ε
805	0.135
808	0.161
1128	0.477
1402	0.711
1442	0.722

* Not shown on plot

DATA ANALYSIS

The objective of the Analyzed Data Graphs is to give the user an evaluative review of available experimental data. It is quite apparent from a study of data sheets of the previous section that the analysis effort is first a filtering process; it identifies the data which are felt to be reliably or typically identified with the materials and gives the user a good deal of "relief" from the "spaghetti" type of presentation shown on the original or archival graphs. However, even these original graphs are the result of some filtering where grossly uncharacterized and second hand data sources have not been included. For certain circumstances of surface preparation and/or environmental conditions, data can be used with some degree of confidence but a great deal of data can only be considered as typical within certain limits.

The procedure for generating the Analyzed Data Graph varies according to the experimental evidence available for all the related sub-properties of the material being studied. Where there is some assurance that the data are well characterized and can be used with some confidence in engineering applications, the analyzed curve is shown as a solid line. A dotted line curve is used for reasonable extrapolations of well characterized conditions and for conditions felt to be typical and as such should be used with some caution. Shaded areas between solid lines are indicative of the limits in which so-called "typical" data will be found.

Each of the curves or areas is identified by key words which are felt descriptive of the surface conditions, etc.; frequently, these words are seen to be incomplete descriptions and the user will find it necessary, if not desirable in all cases, to consult the specification tables for a more complete description of the test conditions being represented. For this reason, the analyzed data graphs show the original curve number identifying the particular set(s) of data used to derive the analyzed curve.

In the SERIES Volume 7 nearly 25 percent of the data will be represented in analyzed or evaluated form. The sample figures presented in the previous section are some extreme examples selected to demonstrate the variety of approaches used to increase the value of the data to the user. The subsequent remarks on the data sheets of the previous section should give the reader of the

report some appreciation for the procedure/technique used in the data evaluation work.

ALUMINUM - For nearly all the materials, one of the first sets of data to be identified is the ideal surface conditions typified by the terms evaporated films for this material (and also electropolished for other materials to be discussed); the curves 4, 5, 15 and 29 when combined, and also interpolated in the near UV, give the reflectivity of well prepared "evaporated films". Bulk material polished by various techniques is identified by the broad band "polished" according to curves 9, 20 and 26; curve 17, the only visible data, also labeled "polished", is represented by a dashed line since it is uncharacterized data. The other curves on the same figure are all represented by solid lines because the surface conditions are characterized, could possibly be reproduced, and would be useful for many engineering applications.

COPPER - The figure for the normal spectral absorptance (room temperature) demonstrates the use of simply related sub-property data; in this case the results of analysis on the reflectance has been used to generate the absorptance in the visible region. The surface conditions - "electropolished & films" - for original measurements of both reflectance and absorptance have been evaluated to give a consistent recommended curve. The other curve on the figure labeled "mechanically polished, 6" demonstrates the influence of polishing techniques on the sub-property. Other data is shown on the original data sheet, but is seen to lack any particular value in demonstrating an effect or trend.

GALLIUM - The spectral transmittance data for this material has been presented in a hybrid manner; it is indicative of our philosophy to present the data based upon technical clarity. The measurements have been grouped into two figures distinguishing the high and low evaporation rate data. The curves are represented by the original data points and identified only by curve number. This data has not really been analyzed in depth but rather it has been filtered based upon some evaporation rate considerations. The reader has the obligation of labeling the curves as he sees fit and also of determining the reliability of the data which is not apparent without some other supporting data.

MOLYBDENUM - The analyzed data graph for the hemispherical total emittance demonstrates the effective use of bands indicative of limits of an effect, in this

case, for "polished" and "grit blasted conditions". It is assumed for all these curves an attempt is made to retard oxidation; this is the general case unless otherwise specified. The "stably oxidized at 811 K, 3" curve has a note warning the user about an extrapolation to higher temperatures in a vacuum; this note is not based upon data at hand, but rather reflects the experience of the analysis workers.

TUNGSTEN - This graph for the normal spectral emittance shows separately the very special case of "annealed aged ribbon" as commonly found in strip lamps or otherwise can be readly obtained and prepared; this data has its special uses and deserves to be distinguished from other types of specimens. The remaining data is analyzed in a manner consistent with the previous materials. It is especially interesting to note that the most significant information in 97 original data curves has been very concisely shown on one uncluttered graph.

STAINLESS STEEL - The original data graph for the normal total emittance contains 132 curves for measurements on the various alloys in extreme variations of surface conditions; it is understandable that the curves range in emittance from 0 to 1 and fill the whole graph. The first step in the analysis effort was to separate the data into three major groups: polished, cleaned and oxidized. It was quickly apparent that the influence of composition or alloy identification was lost by comparison to environmental effects; the exception to this in N-155. The remaining steps in the analysis procedure were to identify typical conditions.

SUMMARY

This report has described in some detail the problems and progress of a comprehensive program for the compilation and analysis of thermal radiative properties data. The procedures for compilation of the literature - an operation in scientific documentation and data extraction - draws upon the experience of TPRC as an information center*. The analysis work is an evaluative review of the literature attempting to filter out data thought to be of little value and to "recommend" data which is of engineering application use.

*Appendix E, TPRC-Information Center for Thermophysics Research, discusses in some detail the objective and activities of TPRC.

The results of this program will be available as the TPRC SERIES, a collection of three volumes distributed as a commercial publication. With an audience of diversified interests and backgrounds, the SERIES has been designed to be authorative and yet simple to use; the need for this reference work has necessarily caused a compromise between availability and completeness of coverage. A special feature of this publication, quite distinctive from other data sources or handbooks, is the continuing program to upgrade or maintain its coverage current and the user can always get the "last word" from the SERIES generator, TPRC.

A program of this magnitude with such wide objectives can benefit from the reaction of the technical community. Reaction to the SERIES is very much desired whether it be technical in nature or in regard to the organization or structure. A technical problem of current concern is the Classification Scheme for Coatings. The program can also benefit from personal assistance of specialists in this field - as new papers or reports are generated they should be forwarded to TPRC for their immediate addition to the System; in this direct and simple manner, the coverage can be made current.

REFERENCES

1. Thermophysical Properties Research Literature Retrieval Guide, Revised and Expanded Edition, Y.S. Touloukian (Editor), The Plenum Publishing Corporation, 1967.

2. Description of a Continuing Program on Tables of Thermophysical Properties of Materials, C. Y. Ho, Air Force Systems Command, Wright-Patterson Air Force Base, Ohio, AFML-TR-68-98, May 1968.

3. Thermal Conductivity of Selected Materials, C. Y. Ho, R. W. Powell, and P. E. Liley, NSRDS-NBS 16, 1968.

APPENDIX A

Table of Contents

TPRC Series, Volume 7
Thermal Radiative Properties
of
Metallic Elements and Alloys

CONTENTS

NUMERICAL DATA

APPENDIX B

Sub-property Nomenclature, Definitions, and Classification

TPRC Series, Volume 7
Thermal Radiative Properties
of
Metallic Elements and Alloys

1.0 Primary Property Definitions

The primary radiation properties -- emittance, reflectance, absorptance, and transmittance -- are all dimensionless quantities descriptive of the radiant energy transport process. They are defined as follows:

Emittance	ratio of the emitted flux per unit area to that of a blackbody radiator at the same temperature, and the same wavelength and geometric viewing conditions.
Reflectance	ratio of some specified portion of the reflected radiant flux to the incident radiant flux.
Absorptance	ratio of the absorbed radiant flux to the incident radiant flux.
Transmittance	ratio of some specified portion of the transmitted radiant flux to the incident radiant flux.

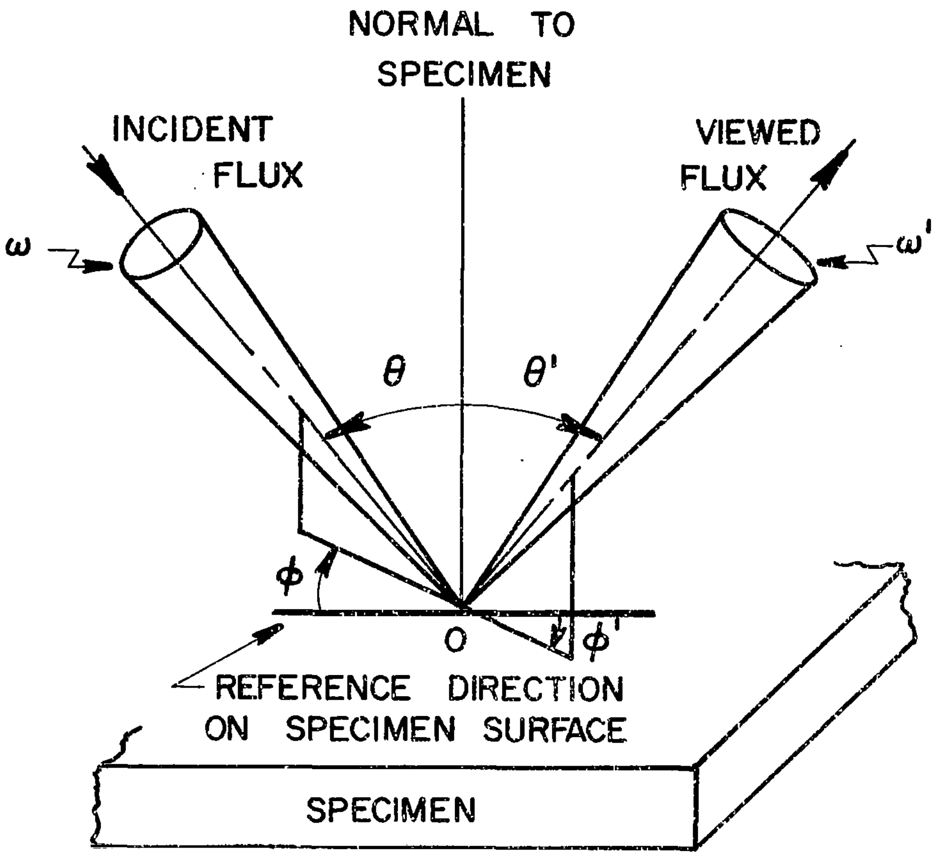
To present the data in a more concise form for efficient retrieval, the primary properties are further categorized into sub-properties. Since there is no universally accepted nomenclature for this division, it has been necessary to develop a consistent set of terms to unambiguously represent the various sub-properties. For the most part, the nomenclature, fully described in the next section, approximates common usage and lends itself well to the compact and systematic organization required of such comprehensive work.

2.0 Sub-Property Designation

Each of the primary properties needs to be further specified by descriptors indicating the geometry of the incident and/or viewing conditions, and the wavelength condition. It is the convention here to list these discriptors in the following order: geometry of incidence (or viewing) and wavelength condition. The terminology of these descriptors is now further discussed.

2.1 Geometry descriptors

These descriptors designate the geometric conditions of incidence and/or viewing (in that order) under which the sample is being observed. Figure B-1 defines the six (6) parameters required to completely specify the incidence and viewing conditions.



θ	Zenith Angle or Co-Latitude, $^{\circ}$
ϕ	Azimuthal Angle or Longitude, $^{\circ}$
ω	Beam Solid Angle, Steradians
'	(Prime) Refers to Viewing Conditions

FIGURE B-1. NOTATION FOR DESCRIBING GEOMETRIC CONDITIONS

For the purpose of categorizing the various sub-properties, the following three terms are used as the geometric descriptors for all of the primary properties.

Angular	conditions for incidence and/or viewing through a solid angle (steradians) ω and/or ω' at some direction specified by θ or θ' $\geq 15^{\circ}$.
Normal	conditions for incidence and/or viewing through a solid angle ω and/or ω', nearly normal to the specimen (to be interpreted as θ or $\theta' < 15^{\circ}$).
Hemispherical	conditions for incidence and/or viewing the flux over a hemispherical region; beam geometry, ω or ω' indicated as 2π.

The selection of these descriptors is at best a compromise with standard practice and convenience. For emittance and absorptance, only one beam need be specified - viewing and incidence respectively. For reflectance and transmittance, the geometry of two beams must be specified. However, for convenience it is desirable to group the reflectance and transmittance data as follows: those sub-properties with common <u>incidence</u> geometric descriptors are grouped together.

The grouping of reflectance and transmittance sub-properties by common incidence conditions deserves some explanation. A grouping scheme is desirable to reduce the physical size of the book, and equally important, to bring together simply related sub-properties allowing the user to locate fragments of data that can be put together to generate information not found directly. For example, if one desires information on normal emittance or normal absorptance, it can easily be calculated from the following equation under certain conditions.

$$\epsilon(0^{\circ}) = \alpha(0^{\circ}) = 1 - \rho(0^{\circ}, 2\pi) - \tau(0^{\circ}, 2\pi)$$

If the sample is opaque, the equation simplifies to

$$\epsilon(0^{\circ}) = \alpha(0^{\circ}) = 1 - \rho(0^{\circ}, 2\pi)$$

and the calculation can be made by simply using normal reflectance.

"Reflectance factor" data is classified according to the sub-property of reflectance which it most nearly approximates. For instance, consider a reflectometer which hemispherically (diffusely), illuminates a specimen and views normally through a small solid angle. If the reflectometer then determins the ratio of the reflected flux from the specimen to that reflected from a perfect diffusing standard, the sub-property is the reflectance factor, $\beta(2\pi, 0^{\circ})$. This is numerically equal to the reflectance sub-property $\rho(0^{\circ}, 2\pi)$. Such data is included in the "normal" category and a note added that it is in reality a reflectance factor.

2.2 Wavelength descriptors

These descriptors indicate spectrum conditions for which the observations are reported. They are:

Spectral	nearly monochromatic or a very narrow band
Total	relative to blackbody wavelength distribution; applicable only to emittance
Integrated	relative to some specified wavelength distribution of the irradiating source or a broad band
Solar	relative to the wavelength distribution of the sun, natural or simulated

The terms "spectral", "total" and "solar" are in common use and need little justification, the last term being a special case of "integrated", separately categorized because of the great current interest in solar property data.

The term "integrated" is a compromise as it has not been used extensively in the literature. The intent here is to group under this term data for broad wavelength bands, over spectral regions of a source, etc. A synonym for this term could be heterochromatic.

3.0 Sub-Property Groupings

The following Table B-1 lists the grouping of the various sub-properties that are presented in the book. This shows that thirty-three (33) sub-properties are classified for retrieval and organizational purposes. The amount of existing data for some of these sub-properties is quite small, but there are good

reasons to present the data using this generalized scheme. First, the clarity of presentation is better by not grouping together data which logically are unrelated. Also, this scheme lends itself especially well to up-dating and expansion in the future.

TABLE B-1. SUB-PROPERTY DESIGNATION

EMITTANCE

Hemispherical Total Emittance
Normal Total Emittance
Angular Total Emittance

Hemispherical Spectral Emittance
Normal Spectral Emittance
Angular Spectral Emittance

REFLECTANCE*

Hemispherical Integrated Reflectance
Normal Integrated Reflectance
Angular Integrated Reflectance

Hemispherical Spectral Reflectance
Normal Spectral Reflectance
Angular Spectral Reflectance

Hemispherical Solar Reflectance
Normal Solar Reflectance
Angular Solar Reflectance

ABSORPTANCE

Hemispherical Integrated Absorptance
Normal Integrated Absorptance
Angular Integrated Absorptance

Hemispherical Spectral Absorptance
Normal Spectral Absorptance
Angular Spectral Absorptance

Hemispherical Solar Absorptance
Normal Solar Absorptance
Angular Solar Absorptance

TRANSMITTANCE*

Hemispherical Integrated Transmittance
Normal Integrated Transmittance
Angular Integrated Transmittance

Hemispherical Spectral Transmittance
Normal Spectral Transmittance
Angular Spectral Transmittance

Hemispherical Solar Transmittance
Normal Solar Transmittance
Angular Solar Transmittance

*The geometry descriptors refer to the conditions of the incident radiant flux.

APPENDIX C

Material Index
and
Grouping of Materials and List
of Figures and Tables

TPRC Series, Volume 7
Thermal Radiative Properties
of
Metallic Elements and Alloys

MATERIAL INDEX

Sub-property code	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
	EMITTANCE						REFLECTANCE									ABSORPTANCE									TRANSMITTANCE									
	Total			Spectral			Integrated			Spectral			Solar			Integrated			Spectral			Solar			Integrated			Spectral			Solar			
Material Name	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Alpha/Epsilon
Alcoa No. 2 reflector plate	2 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	37 39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Allegheny Alloy No. 66	-	1120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Allegheny Metal	-	1160	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aluminum	1	6	-	-	10	13	16	-	18	20	23	30 34	-	36	-	38	41	-	-	43	46	-	48	51	-	-	-	-	53	56	-	-	-	59
Aluminum 1075	-	-	-	-	-	-	-	-	-	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aluminum 1100	-	8	-	-	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aluminum foil	3 4	7	-	-	-	-	-	-	-	-	24 25	-	-	-	-	39	-	-	-	-	46	-	-	-	-	-	-	-	-	56	-	-	-	-
Aluminum alloys:																																		
24-ST	1004	1007 1008	-	-	-	-	-	1014	-	-	1018	-	-	-	-	-	-	-	-	-	-	-	1027	-	-	-	-	-	-	-	-	-	-	-
53-SO	-	1042	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75-ST	-	1061	-	-	-	-	-	1070	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1075	-	-	-	-	-	-	-	-	-	-	-
2024	1004	-	-	-	1011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1027	-	-	-	-	-	-	-	-	-	-	-
2024-T (see 24-ST)																																		

Index

	EMITTANCE						REFLECTANCE									ABSORPTANCE									TRANSMITTANCE									
	Total			Spectral			Integrated			Spectral			Solar			Integrated			Spectral			Solar			Integrated			Spectral			Solar			
Sub-property code	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Material Name	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Alpha/Epsilon
Aluminum alloys (continued)																																		
2219.	-	-	-	-	-	-	-	1014	-	-	1018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3003.	1054	1056	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5053-O (see 53-SO)																																		
6061.	1039	-	-	-	-	-	-	1045	-	-	1048	-	-	-	-	-	-	-	-	-	-	-	1052	-	-	-	-	-	-	-	-	-	-	-
7075.	-	-	-	-	1064	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7075-T (see 75-ST)																																		
7075-T6	-	-	-	-	-	1067	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alclad 24-SO	-	-	-	-	-	-	-	-	-	-	-	-	-	1024	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alclad 24-ST	-	1007 1008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alclad 75-ST	1058	1061	-	-	-	-	-	-	-	-	-	-	-	1072	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alclad 2024-O (see Alclad 24-SO)																																		
Alclad 2024-T (see Alclad 24-ST)																																		
Alclad 7075-T (see Alclad 75-ST)																																		
L34	-	-	-	-	-	-	-	-	-	-	1030	-	-	1033	-	-	-	-	-	-	-	-	1037	-	-	-	-	-	-	-	-	-	-	-
L72	-	-	-	-	-	-	-	-	-	-	-	-	-	1024	-	-	-	-	-	-	-	-	1027	-	-	-	-	-	-	-	-	-	-	-

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	EMITTANCE						REFLECTANCE									ABSORPTANCE									TRANSMITTANCE									
	Total			Spectral			Integrated			Spectral			Solar			Integrated			Spectral			Solar			Integrated			Spectral			Solar			
Sub-property code	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Material Name	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Alpha/Epsilon
Aluminum bronze	-	1097	-	-	1100	-	-	-	-	-	1104	-	-	-	-	-	-	-	-	-	-	-	1107	-	-	-	-	-	-	-	-	-	-	-
Aluminum + Cobalt	-	-	-	-	-	-	-	-	-	-	837	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aluminum + Copper + ΣX_i .	1003	1006	-	-	1010	-	-	1013	-	-	1017	-	-	1023	-	-	-	-	-	-	-	-	1026	-	-	-	-	-	-	-	-	-	-	-
Aluminum + Iron + ΣX_i . .	-	-	-	-	-	-	-	-	-	-	1029	-	-	1032	-	-	-	-	-	-	-	-	1036	-	-	-	-	-	-	-	-	-	-	-
Aluminum + Magnesium . .	-	-	-	-	-	-	-	-	-	-	840	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aluminum + Magnesium + ΣX_i	1039	1041	-	-	-	-	-	1044	-	-	1047	-	-	-	-	-	-	-	-	-	-	-	1052	-	-	-	-	-	-	-	-	-	-	-
Aluminum + Manganese + ΣX_i	1054	1056	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aluminum + Silicon	-	-	-	-	-	-	-	-	-	-	843	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aluminum + Silver	-	-	-	-	-	-	-	-	-	-	846	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aluminum + Zinc + ΣX_i . .	1058	1060	-	-	1063	1066	-	1069	-	-	-	-	-	1072	-	-	-	-	-	-	-	-	1074	-	-	-	-	-	-	-	-	-	-	-
Antimony	-	-	-	-	-	-	-	-	-	-	-	61	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	64	-	-	-	-	-
Armco Iron	291	294	-	-	-	-	304	-	-	306	311	-	-	-	-	-	-	-	-	-	-	-	322	-	-	-	-	-	-	-	-	-	-	-
Astrolloy	-	-	-	-	1303 1348	-	-	-	-	-	1318 1352	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AZ-31.	-	1268	-	-	-	-	-	1271	-	-	1278	-	-	-	-	-	-	-	-	-	-	-	1280	-	-	-	-	-	-	-	-	-	-	-
AZ-31B	-	-	-	-	-	-	-	-	-	1274	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Barium	-	-	-	-	-	-	-	-	-	-	-	66	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Beryllium	-	69	-	-	72 74	-	-	76	-	-	78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	82	-	-	-	-	-

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Sub-property code	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
	EMITTANCE						REFLECTANCE								
	Total			Spectral			Integrated			Spectral			Solar		
Material Name	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular
Beryllium extrusion #30	-	-	-	-	-	-	-	76	-	-	79	-	-	-	-
Beryllium + Iron + ΣX_i	-	-	-	-	-	-	-	-	-	-	-	1077	-	-	-
Bismuth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bismuth + Tin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brass	862	865	-	-	-	-	-	-	-	-	-	-	-	-	-
Brass, α	-	-	-	-	-	-	-	-	-	-	-	871	-	-	-
Brass, β	-	-	-	-	-	-	-	-	-	-	-	871	-	-	-
Brass, yellow	862	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bronze	-	-	-	-	-	-	-	-	-	-	868	-	-	-	-
B.S. 1433 Copper	-	-	-	-	-	-	-	-	-	-	-	-	-	170 171	-
Cadmium	91	-	-	-	-	-	-	-	-	-	-	93	-	-	-
Chromium	101	103	-	-	106 108	-	110	-	-	-	112	115	-	-	-
Cobalt	-	125	-	-	128	-	-	-	-	-	-	133	-	-	-
Cobalt alloy N-155	-	1120 1121 1157 1161	-	-	1124 1169	-	-	-	-	-	1138 1203	-	-	-	-
Cobalt + Aluminum	-	-	-	-	-	-	-	-	-	-	851	-	-	-	-
Cobalt + Chromium + ΣX_i	1080	1083	-	-	1086 1087	-	-	-	-	-	1092	-	-	-	-

Sub-property code	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
	ABSORPTANCE									TRANSMITTANCE									
	Integrated			Spectral			Solar			Integrated			Spectral			Solar			
Material Name	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Alpha/Epsilon
Beryllium extrusion #30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Beryllium + Iron + ΣX_i	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bismuth	-	-	-	-	-	-	-	-	-	-	-	-	-	85	88	-	-	-	-
Bismuth + Tin	-	849	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brass	-	875	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brass, α	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brass, β	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brass, yellow	873	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bronze	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B.S. 1433 Copper	-	-	-	-	-	-	-	189	-	-	-	-	-	-	-	-	-	-	-
Cadmium	96	-	-	-	-	98	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	-	-	-	-	117	-	-	120	-	-	-	-	-	122	-	-	-	-	-
Cobalt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobalt alloy N-155	-	-	-	-	-	-	-	1147 1234 1236	-	-	-	-	-	-	-	-	-	-	-
Cobalt + Aluminum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobalt + Chromium + ΣX_i	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	EMITTANCE						REFLECTANCE									ABSORPTANCE									TRANSMITTANCE									
	Total			Spectral			Integrated			Spectral			Solar			Integrated			Spectral			Solar			Integrated			Spectral			Solar			
Sub-property code	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Material Name	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Alpha/Epsilon
Cobalt + Iron	-	-	-	-	854	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobalt + Nickel	-	-	-	-	856	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cockron home foil	2 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	38 39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Copper	136	140	-	-	146 149	-	-	-	-	154	156	162 164 167	-	169	-	174	176	-	-	178 180	183	186	188	-	-	-	-	-	192	-	-	-	-	195
Copper, B.S. 1433	-	-	-	-	-	-	-	-	-	-	-	-	-	170 171	-	-	-	-	-	-	-	-	189	-	-	-	-	-	-	-	-	-	-	-
Copper, OFHC	137	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	184	-	-	-	-	-	-	-	-	-	-	-	-	-
Copper + Aluminum + ΣX_i .	-	1096	-	-	1099	-	-	-	-	-	1103	-	-	-	-	-	-	-	-	-	-	-	1106	-	-	-	-	-	-	-	-	-	-	-
Copper + Nickel	-	858	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Copper + Nickel + ΣX_i . .	-	-	-	-	-	-	-	-	-	-	1109	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Copper + Tin	-	-	-	-	-	-	-	-	-	-	860	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Copper + Tin + ΣX_i . . .	-	-	-	-	-	-	-	-	-	1111	1113	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Copper + Zinc	862	864	-	-	-	-	-	-	-	-	867	870	-	-	-	873	875	-	-	-	877	-	-	-	-	-	-	-	-	-	-	-	-	-
Copper + Zinc + ΣX_i . . .	-	-	-	-	-	-	1115	-	-	1117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D-43	1402	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Erbium	-	-	-	-	197	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gadolinium	-	-	-	-	-	-	-	-	-	-	199	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	202	-	-	-	-	-
Gallium	-	-	-	-	-	-	-	-	-	-	205	-	-	-	-	-	-	-	-	208	-	-	-	-	-	-	-	-	211	-	-	-	-	-

	EMITTANCE						REFLECTANCE									ABSORPTANCE									TRANSMITTANCE									
	Total			Spectral			Integrated			Spectral			Solar			Integrated			Spectral			Solar			Integrated			Spectral			Solar			
Sub-property code	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Material Name	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angul. r	Alpha/Epsilon
Germanium	-	214	-	-	217 219	-	-	-	-	-	221	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	227	230	-	-	-	-
Gold	233	236	-	-	239 241	-	-	-	-	-	244	249	-	252	-	254	-	-	-	256 258	260	-	262	-	-	-	-	-	-	-	-	-	-	265
Gold + Silver	-	-	-	-	-	-	-	-	-	-	880	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hafnium	267	-	-	-	269 271	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hastelloy X.	-	-	-	-	1304	-	-	-	-	-	1319	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Haynes Alloy No. 25. . . .	1081	1084	-	-	1087 1090	-	-	-	-	-	1093	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Haynes Alloy N-155	-	1162	-	-	1171	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Haynes Alloy X	1289	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hastelloy B.	-	1382	-	-	1385	-	-	-	-	-	1388	-	-	-	-	-	-	-	-	-	-	-	1391	-	-	-	-	-	-	-	-	-	-	-
Hastelloy C.	1379	1382	-	-	1385	-	-	-	-	-	1388	-	-	-	-	-	-	-	-	-	-	-	1391	-	-	-	-	-	-	-	-	-	-	-
HK-31	-	1282	-	-	1284	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1286	-	-	-	-	-	-	-	-	-	-	-
Hurwich home foil	2 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	38 39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Inconel.	1289 1290	1294 1295	-	-	1303 1306	-	-	-	-	-	1323	-	-	-	-	-	-	-	-	1334	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Inconel 600 (see Inconel)																																		
Inconel 702	1290	-	-	-	1304	-	-	-	-	-	1319	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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	EMITTANCE						REFLECTANCE									ABSORPTANCE									TRANSMITTANCE									
	Total			Spectral			Integrated			Spectral			Solar			Integrated			Spectral			Solar			Integrated			Spectral			Solar			
Sub-property code	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Material Name	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Alpha/Epsilon
Inconel B	-	1293	-	-	-	-	-	1315	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1339	-	-	-	-	-	-	-	-	-	-	-
Inconel X	1289 1290	1294 1295 1296	-	-	1300 1305	-	-	1315	-	-	1318 1320	-	-	-	-	-	-	-	-	-	1336	-	1339 1340	-	-	-	-	-	-	-	-	-	-	-
Inconel X-750 (see Inconel X)																																		
Indium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	273	-	-	-	-	-	-	-	-	-	-	-	-	-
Inor-8	1379	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iodide Hafnium	267	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iodine	-	-	-	-	-	-	-	-	-	-	276	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iridium	-	-	-	-	278 280	-	-	-	-	-	283	286 288	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	290	293	-	-	296 301	-	304	-	-	306	308 310	313	-	-	-	-	-	-	-	316 318	-	-	321	-	-	-	-	-	-	-	-	-	-	-
Iron + Carbon	-	883	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron + Chromium	-	-	-	-	-	-	-	-	-	-	886	888	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron + Chromium + ΣX_i . .	-	1119	-	-	1123 1127	-	1132	-	-	1134	1137	-	-	-	-	-	-	-	-	1143	-	-	1146	-	-	-	-	-	-	-	-	-	-	-
Iron + Chromium + Nickel + ΣX_i	1149	1155	1166	-	1168 1175	1183 1186	1192	1194	-	1199	1202	1220 1222	-	-	-	1224	-	-	-	1226	1229	-	1232	-	-	-	-	-	-	-	-	-	-	1238
Iron + Cobalt + ΣX_i	-	-	-	-	-	-	1240	-	-	1242	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron + Manganese + ΣX_i . .	1244	1246	-	-	-	-	1248	-	-	1250	-	-	-	-	-	-	-	-	-	-	-	-	1252	-	-	-	-	-	-	-	-	-	-	-

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	EMITTANCE						REFLECTANCE									ABSORPTANCE									TRANSMITTANCE									
	Total			Spectral			Integrated			Spectral			Solar			Integrated			Spectral			Solar			Integrated			Spectral			Solar			
Sub-property code	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Material Name	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Alpha/Epsilon
Iron + Nickel	-	-	-	-	890	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron + Nickel + ΣX_i	-	-	-	-	-	-	-	-	-	-	1255	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron + Nickel + Chromium + ΣX_i	1258	-	-	-	1261	-	-	-	-	-	1264	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron + Tungsten	-	-	-	-	893	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
K Monel	-	1360	-	-	-	-	-	1365	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1373	-	-	-	-	-	-	-	-	-	-	-
KR Monel	-	-	-	-	-	-	1362	-	-	1367	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kaiser foil	2 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kanthal	-	-	-	-	1128	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1144	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kanthal A	-	-	-	-	1128	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Konel	1342	-	-	-	1345	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kovar	-	-	-	-	-	-	-	-	-	-	1256	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
L34	-	-	-	-	-	-	-	-	-	-	1030	-	-	1033	-	-	-	-	-	-	-	-	1037	-	-	-	-	-	-	-	-	-	-	-
L72	-	-	-	-	-	-	-	-	-	-	-	-	-	1024	-	-	-	-	-	-	-	-	1027	-	-	-	-	-	-	-	-	-	-	-
L120 Magnesium	-	-	-	-	-	-	-	-	-	-	-	-	-	350 351	-	-	-	-	-	-	-	-	354	-	-	-	-	-	-	-	-	-	-	-
Lead	324	326	-	-	-	-	-	-	-	-	-	-	-	-	-	328	330	-	-	332	334	-	-	-	-	-	-	-	-	-	-	-	-	-
Lead + Tin	896	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lutetium	-	-	-	-	-	-	-	-	-	-	336	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	339	-	-	-	-	-

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	EMITTANCE						REFLECTANCE									ABSORPTANCE									TRANSMITTANCE									
	Total			Spectral			Integrated			Spectral			Solar			Integrated			Spectral			Solar			Integrated			Spectral			Solar			
Sub-property code	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Material Name	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Alpha/Epsilon
M252	-	-	-	-	1306	-	-	-	-	-	1323	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Magnesium	342	-	-	-	-	-	-	-	-	-	345	347	-	349	-	-	-	-	-	-	-	-	353	-	-	-	-	-	356	-	-	-	-	-
Magnesium, L120	-	-	-	-	-	-	-	-	-	-	-	-	-	350 351	-	-	-	-	-	-	-	-	354	-	-	-	-	-	-	-	-	-	-	-
Magnesium alloys:																																		
AZ-31	-	1268	-	-	-	-	-	1271	-	-	1278	-	-	-	-	-	-	-	-	-	-	-	1280	-	-	-	-	-	-	-	-	-	-	-
AZ-31B	-	-	-	-	-	-	-	-	-	1274	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HK-31	-	1282	-	-	-	-	-	-	-	-	1284	-	-	-	-	-	-	-	-	-	-	-	1286	-	-	-	-	-	-	-	-	-	-	-
Magnesium + Aluminum	-	-	-	-	-	-	-	-	-	-	898	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Magnesium + Aluminum + ΣX_i	-	1267	-	-	-	-	-	1270	-	1273	1277	-	-	-	-	-	-	-	-	-	-	1280	-	-	-	-	-	-	-	-	-	-	-	-
Magnesium + Thorium + ΣX_i	-	1282	-	-	-	-	-	-	-	-	1284	-	-	-	-	-	-	-	-	-	-	-	1286	-	-	-	-	-	-	-	-	-	-	-
Manganese	-	-	-	-	358	-	-	-	-	-	-	360	-	-	-	-	-	-	-	-	363	-	-	-	-	-	-	-	-	-	-	-	-	-
Mild steel	1244	1246	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1253	-	-	-	-	-	-	-	-	-	-	-
Mo + 0.5 Ti alloy	-	902	905	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum	365	370	-	-	374 379	-	-	-	-	-	384	388	-	-	-	-	-	-	-	390	393	-	396	-	-	-	-	-	-	-	-	-	-	-
Molybdenum + Titanium	-	901	904	-	907	-	-	-	-	-	910	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum + Tungsten	914	-	-	-	916	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Monel	1357	1360	-	-	-	-	-	-	-	-	1370	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	EMITTANCE						REFLECTANCE									ABSORPTANCE									TRANSMITTANCE									
	Total			Spectral			Integrated			Spectral			Solar			Integrated			Spectral			Solar			Integrated			Spectral			Solar			
Sub-property code	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Material Name	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Alpha/Epsilon
Monel 400 (see Monel)																																		
Monel K-500 (see K Monel)																																		
Monel 501 (see KR Monel)																																		
Multimet	1152	1162	-	-	1171	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nb - 1 Zr alloy	934	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nichrome	1289	1296	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	399	402	-	-	408 417	-	422	424	428	-	434	437	-	-	-	440	442	-	-	444	447	450	452	-	-	-	-	-	-	-	-	-	-	455
Nickel, Grade A	-	403 404 405	-	-	409 410 411 412	-	-	-	-	-	435	-	-	-	-	-	-	-	-	-	-	-	453	-	-	-	-	-	-	-	-	-	-	-
Nickel, Grade NP-3	-	-	-	-	418	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel + Chromium	-	-	-	-	919	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel + Chromium + ΣX_i . .	1288	1292	-	-	1299 1302	-	-	1314	-	-	1317	-	-	-	-	-	-	-	-	1333	1336	-	1338	-	-	-	-	-	-	-	-	-	-	-
Nickel + Cobalt + ΣX_i . . .	1342	-	-	-	1344 1347	-	-	-	-	-	1351	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel + Copper + ΣX_i . . .	1357	1359	-	-	-	-	1362	1364	-	1367	1369	-	-	-	-	-	-	-	-	-	-	-	1372	-	-	-	-	-	-	-	-	-	-	-
Nickel + Iron	-	-	-	-	922	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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	EMITTANCE						REFLECTANCE									ABSORPTANCE									TRANSMITTANCE									
	Total			Spectral			Integrated			Spectral			Solar			Integrated			Spectral			Solar			Integrated			Spectral			Solar			
Sub-property code	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Material Name	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Alpha/Epsilon
Nickel + Iron + ΣX_i	-	-	-	-	1375	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel + Molybdenum + ΣX_i	1378	1381	-	-	1384	-	-	-	-	-	1387	-	-	-	-	-	-	-	-	-	-	-	1390	-	-	-	-	-	-	-	-	-	-	-
Nickel silver	-	-	-	-	-	-	1115	-	-	1117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel + Silver	-	925	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nimonic 75	1290	1293	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Niobium	457	462	-	-	464 467	-	-	-	-	-	471	-	-	-	-	-	-	-	-	-	475	-	-	-	-	-	-	-	-	-	-	-	-	-
Niobium + Molybdenum + ΣX_i	-	1393	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Niobium + Tantalum + ΣX_i .	1395	-	-	-	1398	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Niobium + Tungsten	927	-	-	-	930	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Niobium + Tungsten + ΣX_i	1401	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Niobium + Zirconium . . .	933	936	-	-	938	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OFHC Copper	137	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	184	-	-	-	-	-	-	-	-	-	-	-	-	-
Osmium	-	-	-	-	478	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Palladium	480	482	-	-	485 488	-	-	-	-	-	490	-	-	-	-	-	-	-	-	493	-	-	496	-	-	-	-	-	498	-	-	-	-	-
Phosphor bronze	-	-	-	-	-	-	-	-	-	1111	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Platinum	501	505	-	-	508 511	-	-	-	-	-	518	521 523	-	-	-	-	-	-	-	525	528	-	531	-	-	-	-	-	-	-	-	-	-	-

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	EMITTANCE						REFLECTANCE									ABSORPTANCE									TRANSMITTANCE									
	Total			Spectral			Integrated			Spectral			Solar			Integrated			Spectral			Solar			Integrated			Spectral			Solar			
Sub-property code	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Material Name	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Alpha/Epsilon
Silicon, p-type	-	-	-	-	574	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silver	588	591	-	-	593 595	-	597	-	-	-	599	603	-	-	-	606	-	-	-	608 610	612	-	615	-	-	-	-	-	618	-	-	-	-	621
Silver + Aluminum	-	-	-	-	-	-	-	-	-	-	949	951	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silver + Beryllium	-	-	-	-	-	-	-	-	-	-	-	954	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silver + Cadmium + ΣX_i . .	-	-	-	-	-	-	-	-	-	-	-	1404	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silver + Copper + ΣX_i . . .	-	-	-	-	-	-	-	-	-	-	-	1407	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silver + Gold	-	-	-	-	-	-	-	-	-	-	957	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silver + Silicon	-	-	-	-	-	-	-	-	-	-	-	960	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silver + Zinc + ΣX_i	-	-	-	-	-	-	-	-	-	-	-	1410	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Solder	896	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stainless steel	-	-	-	-	1128	-	-	-	-	-	-	888	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stainless Steels:																																		
17-7 PH	-	1158	-	-	1170 1177	-	-	-	-	-	1203 1205	-	-	-	-	-	-	-	-	-	-	-	1235	-	-	-	-	-	-	-	-	-	-	-
18-8	1150 1152	1160 1161	-	-	-	-	-	-	-	1200	-	-	-	-	-	-	-	-	-	-	-	-	1236	-	-	-	-	-	-	-	-	-	-	-
18-8 Cr-Cu	-	-	-	-	-	-	1132	-	-	1135	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18-20 Cr-Mn	-	-	-	-	-	-	1248	-	-	1250	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18-21 Cr-Co	-	-	-	-	-	-	1240	-	-	1242	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	EMITTANCE						REFLECTANCE								
	Total			Spectral			Integrated			Spectral			Solar		
Sub-property code	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
Material Name	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular
Stainless Steels (continued)															
301	-	1156 1161	-	-	-	-	-	1195 1196	-	-	1206	-	-	-	-
302	1150 1151	-	-	-	-	-	-	-	-	-	-	-	-	-	-
303	1150 1151	1161	-	-	-	1184 1186 1187 1188	-	-	-	-	-	-	-	-	-
304	1151	1162	-	-	1176	-	1192	-	-	1200	1207	-	-	-	-
304 ELC	1151	-	-	-	-	-	-	-	-	-	-	-	-	-	-
309	-	-	-	-	-	-	1192	-	-	1200	-	-	-	-	-
310	1150 1151	-	-	-	-	-	1192	-	-	1200	-	-	-	-	-
316	-	1156 1159	-	-	1170 1176	-	1192	1195	-	1200	1203 1207 1208	-	-	-	-
321	-	1159 1160 1161	-	-	1170 1171 1176 1178	-	-	-	-	-	1203 1204 1207 1209	1222	-	-	-
347	1150	1157	-	-	-	-	-	1196	-	-	-	-	-	-	-
410	-	-	-	-	-	-	1132	-	-	1135	-	-	-	-	-
420	-	-	-	-	-	-	1132	-	-	1135	-	-	-	-	-

	ABSORPTANCE									TRANSMITTANCE									
	Integrated			Spectral			Solar			Integrated			Spectral			Solar			
Sub-property code	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Material Name	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Alpha/Epsilon
Stainless Steels (continued)																			
301	-	-	-	-	-	-	-	1233	-	-	-	-	-	-	-	-	-	-	-
302	1224	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
303	-	-	-	-	-	1230	-	-	-	-	-	-	-	-	-	-	-	-	-
304	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1238
304 ELC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
309	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
310	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
316	-	-	-	-	-	-	-	1233 1235	-	-	-	-	-	-	-	-	-	-	-
321	-	-	-	-	1227	-	-	1235 1236	-	-	-	-	-	-	-	-	-	-	-
347	-	-	-	-	-	-	-	1234	-	-	-	-	-	-	-	-	-	-	-
410	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
420	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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	EMITTANCE						REFLECTANCE									ABSORPTANCE									TRANSMITTANCE									
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Material Name	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Alpha/Epsilon
Stainless Steels (continued)																																		
430	-	-	-	-	-	-	1132	-	-	1135	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
431	-	-	-	-	-	-	1192	-	-	1200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
446	-	1120	-	-	1125	-	1132	-	-	1135	1138	-	-	-	-	-	-	-	-	-	-	-	1147	-	-	-	-	-	-	-	-	-	-	-
A286	-	-	-	-	1262	-	-	-	-	-	1265	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AM 350	-	1160	-	-	1171 1177	-	-	-	-	-	1203 1204 1205	-	-	-	-	-	-	-	-	-	-	-	1235 1236	-	-	-	-	-	-	-	-	-	-	-
PH 15-7 Mo	-	1158	-	-	1170 1177	-	-	-	-	-	1203 1204	-	-	-	-	-	-	-	-	-	-	-	1234	-	-	-	-	-	-	-	-	-	-	-
SF 11	-	-	-	-	-	-	-	-	-	-	886	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SF 20	-	-	-	-	-	-	-	-	-	-	1203	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stellite	-	-	-	-	-	-	-	-	-	-	1093	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T-111	1413	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tantalum	623	627	-	-	631 636	-	-	-	-	-	641	646	-	-	-	-	-	-	-	-	-	-	649	-	-	-	-	-	-	-	-	-	-	-
Tantalum + Tungsten . . .	-	963	-	-	966	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tantalum + Tungsten + ΣX_i	1413	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tellurium	-	-	-	-	-	-	-	-	-	-	-	652	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	655	-	-	-	-	-
Tellurium + Selenium . . .	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	968	-	-	-	-	-

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	EMITTANCE						REFLECTANCE									ABSORPTANCE									TRANSMITTANCE									
	Total			Spectral			Integrated			Spectral			Solar			Integrated			Spectral			Solar			Integrated			Spectral			Solar			
Sub-property code	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Material Name	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Hemispherical	Normal	Angular	Alpha/Epsilon
Thallium	-	-	-	-	-	-	-	-	-	-	660	663	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	666	-	-	-	-	-
Thorium	-	-	-	-	669 671	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tin	673	675	-	-	-	-	-	-	-	-	677	-	-	-	-	680	682	-	-	684	687	-	-	-	-	-	-	-	690	-	-	-	-	-
Tin + Indium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	970	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Titanium	693	696	-	-	699 702	705 708	-	-	-	-	712	718	-	733	-	-	-	-	-	-	735	-	-	-	-	-	-	-	737	-	-	-	-	-
Titanium, AMS 4901	-	697	-	-	-	-	-	-	-	-	713	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Titanium, Ti-75 A	694	697	-	-	-	-	-	-	-	-	713	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Titanium alloys:																																		
6Al-4V	1416	1419	-	-	1422 1423	-	-	-	-	-	1426	-	-	-	-	-	-	-	-	-	-	-	1429	-	-	-	-	-	-	-	-	-	-	-
A-110-AT	-	1419	-	-	1422	-	-	-	-	-	1426	-	-	-	-	-	-	-	-	-	-	-	1429	-	-	-	-	-	-	-	-	-	-	-
AMS 4908	-	973	-	-	-	-	-	-	-	-	979	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B120 VAC	-	-	-	-	-	-	-	-	-	1437	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C-110 M	-	973	-	-	976	-	-	-	-	-	979	-	-	-	-	-	-	-	-	-	-	-	982	-	-	-	-	-	-	-	-	-	-	-
RS-120	1431	1434	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TA5E	1416	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TA6V	1416	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Titanium + Aluminum + ΣX_i	1415	1418	-	-	1421	-	-	-	-	-	1426	-	-	-	-	-	-	-	-	-	-	-	1428	-	-	-	-	-	-	-	-	-	-	-

	EMITTANCE						REFLECTANCE									ABSORPTANCE									TRANSMITTANCE									
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Titanium + Manganese . . .	-	972	-	-	975	-	-	-	-	-	978	-	-	-	-	-	-	-	-	-	-	-	982	-	-	-	-	-	-	-	-	-	-	-
Titanium + Manganese + ΣX_i	1431	1433	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Titanium + Vanadium + ΣX_i	-	-	-	-	-	-	-	-	-	1436	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tungsten	739	744	-	-	750 755	766 768	-	-	770	-	772 775	779	-	-	-	-	-	-	-	-	781	-	-	-	-	-	-	-	-	-	-	-	-	-
Tungsten alloys:																																		
VR-27-VT	990	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tungsten + Molybdenum . .	984	-	-	-	986	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tungsten + Rhenium	989	-	-	-	992	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Udimet 500	-	-	-	-	1305 1348	-	-	-	-	-	1322 1352	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unitemp No. 41	-	884 1295	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	784	-	-	-	790 793	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium + Niobium	994	-	-	-	997	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium + Zirconium + ΣX_i .	1439	-	-	-	1442	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranus 10	-	-	-	-	-	-	-	-	-	-	-	1220	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	-	-	-	-	795	-	-	-	-	-	798	801	-	-	-	-	-	-	-	-	803	-	-	-	-	-	-	-	-	-	-	-	-	-
Vascojet 1000	-	-	-	-	1128	-	-	-	-	-	1139	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Vickers F.D.P.	-	1156	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VR-27-VT	990	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellow brass	862	-	-	-	-	-	-	-	-	-	-	-	-	-	-	873	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yttrium	-	-	-	-	806	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	808	810	-	-	-	-	-	-	-	-	812	-	-	-	-	815	-	-	-	817	820	-	-	-	-	-	-	-	-	-	-	-	-	-
Zinc + Aluminum	-	-	-	-	-	-	-	-	-	-	1000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zircalloy 2	-	1448	-	-	1451	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zirconium	-	823	-	-	826 829	-	-	-	-	-	832	-	-	-	-	-	-	-	-	-	834	-	-	-	-	-	-	-	-	-	-	-	-	-
Zirconium + Hafnium + ΣX_i	-	-	-	-	1445	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zirconium + Tin + ΣX_i . . .	-	1447	-	-	1450	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zirconium + Uranium + ΣX_i	1453	-	-	-	1456	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

GROUPING OF MATERIALS AND LIST OF FIGURES AND TABLES

1. ELEMENTS

1. ELEMENTS (continued)

2. BINARY ALLOYS

2. BINARY ALLOYS (continued)

3. MULTIPLE ALLOYS

3. MULTIPLE ALLOYS (continued)

APPENDIX D

References to Data Sources

TPRC Series, Volume 7
Thermal Radiative Properties
of
Metallic Elements and Alloys

REFERENCES TO DATA SOURCES

Ref. No.	TPRC No.	
1	6639	Goodman, S., NBS Rept. 4239, 1-13, 1955. [AD 71409]
2	11723	Reynolds, P.M., Brit. J. Appl. Physics, 12 (3), 111-4, 1961.
3	10185	Fulk, M.M., Reynolds, M.M., and Park, O.E., NBS Rept. 3517, 151-7, 1955. [AD 125047]
4	19293	Reynolds, M.M., Fulk, M.M., Weitzel, D.H., and Park, O.E., Nat'l. Bur. Stds. Cryogenic Eng. Lab., Boulder, Colo., NBS Rept. 2484, 1-10, 1953.
5	25038	Jenkins, R.J., Butler, C.P., and Parker, W.J., USNRDL-TR-663, SSD-TDR-62-189, 1-57, 1963. [AD 419067]
6	27325	Carpenter, W.G.D. and Sewell, J.H., Royal Aircraft Establishment, RAE-TN-CPM-20, 1-9 1963. [AD 418612]
7	26738	Haury, G.L., ASD-TDR-63-146, 1-16, 1963. [AD 411140]
8	22816	Anderson, D.L. and Nothwang, G.J., NASA-TN-D-1646, 1-36, 1963.
9	27333	Ziegler, W.T. and Cheung, H., Advan. Cryog. Eng., 2, 100-3, 1960.
10	4981	Best, G., J. Opt. Soc. Amer., 39 (12), 1009-11, 1949.
11	25811	Carpenter, W.G.D. and Sewell, J.H., Royal Aircraft Establishment (G. Brit.), RAE Rept. CHem-538, 1-6, 1962. [AD 295648]
12	20641	Askwyth, W.H., Yahes, R.J., House, R.D., and Mikk, G., NASA-CR-56496, 56497, 56498, 1-277, 1962.
13	6459	Taylor, C.S. and Edwards, J.D., Heating, Piping, and Air-Conditioning, 11 (1), 59-63, 1939.
14	16426	Randolf, C.P. and Overholzer, M.J., Phys. Rev., 2, 144-52, 1913.
15	9353	Barnes, T.T., Forsythe, W.E., and Adams, E.Q., J. Opt. Soc. Am., 37 (10), 804-7, 1947.
16	6353	McDermott, P.F., Rev. Sci. Instruments, 8 (6), 185-92, 1937.
17	6348	Taylor, C.S., Willey, L.A., Smith, D.W., and Edwards, J.D., Metals and Alloys, 7 (8), 189-92, 1938.
18	30642	Konopken, S. and Klemm, R., NASA-SP-31, 505-13, 1963.
19	22522	Burgess, G.K. and Waltenberg, R.G., Nat'l. Bur. Stds. Bull., 11, 591-605, 1915.
20	8677	Allen, F.G., J. Appl. Phys., 28 (12), 1510-11, 1957.
21	16961	Stierwalt, D.L., Naval Ordnance Lab., NAVWEPS Rept. 7160, NOLC Rept. 537, 1-34, 1961. [AD 250530]
22	6965	Wade, W.R., Langley Aeronaut. Lab., NASA, 1-43, 1958. [AD 153191]
23	5125	Zimmermann, F.J., J. Appl. Phys., 26, 1483-8, 1955.
24	17044	Dunkle, R.V. and Gier, J.T., Univ. Calif., ONR, 1-24, 1948. [ATI 91560]
25	24863	Gaumer, R.E., McKellar, L.A., Streed, E.R., Frame, K.L., and Grammer, J.R., ASME Second Symposium on Thermophysical Properties, Princeton, N.J., 575-87, Jan. 24-6, 1962.
26	35270	Thaler, W.J., Finn, E.J., Treado, P.A., and Nakhleh, J., J. Appl. Opt., 3 (12), 1411-5, 1964.
27	24830	Butler, C.P. and Inn, E.C.Y., First Symposium on Surface Effects on Spacecraft Materials, John Wiley and Sons, Inc., 195-211, 1960.
28	9060	Aref, M.N., ASME-AIChE Joint Heat Transfer Conf., Chicago, Ill., Paper 58-HT-18, 1-15, 1958.
29	8144	Betz, H.T., Olson, O.H., Schurin, B.D., and Morris, J.C., WADC-TR-56-222 (Pt 1), 1-43, 1956. [AD 110458]
30	27592	Seban, R.A., WADD-TR-60-370 (Pt 3), 1-68, 1963. [AD 419028]
31	31741	Southern Research Inst., Birmingham, Ala., NASA-CR-55073, 1-77, 1963.
32	6469	Morris, J.C., Schurin, B., and Olson, O.H., ASME Symp. on Thermal Properties, Purdue Univ., 400-4, 1959.
33	23267	Rudnaya, A.I. and Bostrem, Z.D., Trudy Vsesoyuz Nauch-Issledouatel. Inst. Metrol, (35), 95-107, 1958.
34	6979	Betz, H.T., Olson, O.H., Schurin, B.D., and Morris, J.C., WADC-TR-56-222 (Pt 2), 1-184, 1957. [AD 202493]
35	16427	Bidwell, C.C., Phys. Rev., 3, 439-49, 1914.

Ref. No.	TPRC No.	
36	9910	Stubbs, C.M., Proc. Roy. Soc. (London), A88, 195-205, 1913.
37	5060	Price, D.J., Proc. Phys. Soc. (London), 59 (1), 118-31, 1947.
38	16329	Hurst, C., Proc. Roy. Soc. (London), A142, 466-90, 1933.
39	4783	Wahlin, H.B., Phys. Rev., 73, 1458-9, 1948.
40	24862	Birkebak, R.C., Hartnett, J.P., and Eckert, R.G., ASME Second Symposium on Thermophysical Properties, Princeton, N.J., 563-74, 1962.
41	4113	Ward, L., Proc. Phys. Soc. (London), B69, 339-43, 1956.
42	4830	Wahlin, H.B. and Wright, R., J. Appl. Phys., 13, 40-2, 1942.
43	9899	Lund. H. and Ward, L., Proc. Phys. Soc. (London), B65, 535-40, 1952.
44	7488	Wahlin, H.B. and Knop, H.W., Jr., Phys. Rev., 74, 687-9, 1948.
45	31646	Gaumer, R.E., Clauss, F.J., Sibert, M.E., and Shaw, C.C., WADD-TR-60-773, 117-36, 1961. [AD 267 310]
46	23922	Cline, D. and Kropschot, R.H., Advan. in Cryog. Eng., 7, 534-8, 1962.
47	31650	Butler, C.P., Jenkins, R.J., Rudkin, R.L., and Laughridge, F.I., WADD-TR-60-773, 229-52, 1961. [AD 267 310]
48	31790	Hall, W.M., NASA-CR-56037, 1-8, 1964.
49	9909	Stubbs, C.M. and Prideaux, E.B.R., Proc. Roy. Soc. (London), A87, 451-65, 1912.
50	16284	Worthing, A.G., J. Franklin Inst., 192, 112, 1921.
51	16436	Worthing, A.G., Phys. Rev., 28, 174-89, 1926.
52	4003	Taylor, J.E., J. Opt. Soc. Am., 42, 33-6, 1952.
53	16425	Bidwell, C.C., Phys. Rev., 1, 482-3, 1913.
54	29589	Abbott, G.L., Alvares, N.J., and Parker, W.J., WADD-TR-61-94 (Pt 2), 1-31, 1962. [AD 297 865]
55	16444	Whitney, L.V., Phys. Rev., 48, 458-61, 1935.
56	22542	Davisson, C. and Weeks, J.R., Phys. Rev., 17, 261-3, 1921.
57	41915	Agababov, S.G. and Komarek, A., NLL, RTS-2762, 1-5, 1966.
58	25564	Cade, C.M., IRE Transactions on Electron Devices, ED-8, 56-69, 1961.
59	21110	Abbott, G.L., Alvares, N.J., and Parker, W.J., WADD-TR-61-94, 1-48, 1961. [AD 270 470]
60	16296	Davisson, C. and Weeks, J.R., Jr., J. Opt. Soc. Am., 8, 581-605, 1924.
61	16400	Foote, P.D., J. Wash. Acad. Sci., 5, 1-7, 1915.
62	7189	Krishnan, K.S. and Jain, S.C., Brit. J. Appl. Phys., 5 (12), 1-7, 1915.
63	25127	Shatz, E.A. and McCandless, L.C., ASD-TR-62-443, 1-92, 1962. [AD 281 821]
64	6441	Stephens, R.E., J. Opt. Soc. Am., 29 (4), 158-61, 1939.
65	33603	Seban, R.A., WADD-TR-60-370 (Pt 2), 1-72, 1962. [AD 286 863]
66	10876	Maki, A.G., Stair, R., and Johnston, R.G., J. Res. Nat'l. Bur. Std., 64C (2), 99-102, 1960.
67	30630	McElroy, D.L. and Kollie, T.G., NASA-SP-31, 365-79, 1963.
68	6523	Sully, A.H., Brandes, E.A., and Waterhouse, R.B., Brit. J. Appl. Phys., 3 (3), 97-101, 1952.
69	16635	Rudkin, R.L., USNRDL-TR-433, 1-19. 1960. [AD 244 211]
70	16668	Allen, R.D., Glasier, L.F., Jr., and Jordan, P.L., J. Appl. Phys., 31, 1382-7, 1960.
71	31192	Rudkin, R.L., Parker, W.J., and Jenkins, R.J., Temp. Meas. Control Sci. Ind., 3 (Pt 2), 523-34, 1962.
72	26244	Petrov, V.A., Chekhovskoi, V.Ya., and Sheindlin, A.E., High Temperature, 1 (1), 19-23, 1963.
73	30821	Gordon, A.R. and Muchnik, G.F., High Temperature (USSR), 2 (2), 258-60, 1964.
74	6634	Baldwin, G.J., Shilts, J.L., and Coomes, E.A., Notre Dame Physical Electronic Group Res., ONR, 1-8, 1955. [AD 78 005]
75	24864	Pears, C.D., ASME Second Symposium on Thermophysical Properties, Princeton, N.J., 588-98, 1962.
76	30647	Riethof, T.R. and DeSantis, V.J., NASA-SP-31, 565-84, 1963.
77	6349	Bossart, P.N., Physica, 7 (2), 50-4, 1936.
78	9291	Zwikker, C., Physica, 7, 71-4, 1927.
79	16434	Worthing, A.G., Phys. Rev., 25, 846-57, 1925.

Ref. No.	TPRC No.	
80	10555	Ill. Inst. of Tech., Determination of Emissivity and Reflectivity Data on Aircraft Structural Materials, Progress Rept. No. 9, 1-8, 1956. [AD 122711]
81	11083	Moore, G.E. and Allison, H.W., J. Appl. Phys., 12, 431-5, 1941.
82	16439	Barnes, B.T., Phys. Rev., 34, 1026-30, 1929.
83	22521	Burgess, G.K. and Foote, P.D., Nat'l. Bur. Std. Bull. 11, 41-64, 1915.
84	29504	Allen, R.D., ARS Journal, 32 (6), 965-7, 1962.
85	28741	Abbott, G.L., WADD-TR-61-94 (Pt 3), 1-30, 1963. [AD 435825], [AD 436887]
86	29405	Adams, J.G., Northrop Corp., Novair Dov., 1-259, 1962. [AD 274558]
87	13553	Howl, C.D.A. and Davis, A.F., Brit. J. Appl. Phys., 13 (5), 223-6, 1962.
88	9109	Marple, D.T.F., J. Opt. Soc. Am., 46 (7), 490-4, 1956.
89	10162	Rosenbaum, D.M., Sherwood, E.M., Campbell, I.E., Jaffee, R.I., Sims, C.T., Craighead, C.M., Wyler, E.N., and Todd, F.C., BMI, Investigations of Rhenium, Quarterly Progress Rept. No. 3, 1-40, 1953. [AD 14174]
90	10514	Sims, C.T., Craighead, C.M., Jaffee, R.I., Gideon, D.N., Wayler, E.N., Todd, F.C., Rosenbaum, D.M., Sherwood, E.M., and Campbell, I.E., WADC-TR-54-371, 1-138, 1954. [AD 48279]
91	6460	Sims, C.T., Craighead, C.M., and Jaffee, R.I., AIME Trans., 203, 168-78, 1955.
92	23145	Sklarew, S. and Rabensteine, A.S., Marquardt Corp., Rept. No. PR 281-3Q-1, 1-37, 1963. [AD 299417]
93	11752	Malter, L. and Langmuir, D.B., Phys. Rev., 55, 743-7, 1939.
94	14404	Serebryakova, T.I., Paderno, Yu.B., and Samsonov, G.V., Optics and Spectroscopy (USSR), 8 (3), 212-3, 1960.
95	23126	Coffman, J.A., Kibler, G.M., Lyon, T.F., and Acchione, B.D., WADD-TR-60-646 (Pt 2), 1-183, 1963. [AD 297946]
96	31743	Pratt and Whitney Aircraft. PWA-2309, NASA-CR-58054, 1-83, 1964.
97	5062	Michels, W.C. and Wilford, S., J. Appl. Phys., 20, 1223-6, 1949.
98	18591	Cairns, J.H., J. Sci. Instrum., 37 (3), 84-7, 1960.
99	19724	Bevans, J.T., Gier, J.T., and Dunkle, R.V., Trans. ASME, 80, 1405-16 1958.
100	5025	Bradshaw, F.J., Proc. Phys. Soc. (London), B63, 573-7, 1950.
101	31016	Edwards, J.W., Johnston, H.L., and Ditmars, W.E., J. Am. Chem. Soc., 75, 2467-70, 1953.
102	20450	Forsythe, W.E. and Watson, E.M., J. Opt. Soc. Am., 24, 114-8, 1934.
103	34926	Isreal, S.L., Hawkins, T.D., and Hyman, S.C., NASA-CR-402, 1-46, 1966.
104	28865	Rudkin, R.L., Parker, W.J., and Westover, R.W., USNRDL-TR-419, 1-27, 1960. [AD 240185-L]
105	10768	Jenkins, R.J., Parker, W.J., and Butler, C.P., USNRDL-TR-348, 1-24, 1959. [AD 226896]
106	26008	Pears, C.D., ASD-TDR-62-765, 1-420, 1963. [AD 298061]
107	16727	Pears, C.D., WADC-TR-59-744, Vol. 3, 99-116, 1960. [AD 247110-L]
108	21878	Barnes, B.T., J. Phys. Chem., 33, 688-91, 1929.
109	22616	Reynolds, T.W. and Kreps, L.W., NASA-TN-D-871, 1-43, 1961. [AD 262047]
110	20863	Lockwood, D.L. and Cybulski, R.J., NASA-TN-D-766, 1-53, 1961. [AD 253876]
111	16445	Wahlin, H.B. and Whitney, L.V., Phys. Rev., 50, 735-8, 1936.
112	26981	Kibler, G.M., Lyon, T.F., Linevsky, M.J., and DeSantis, V.J., Gen. Elec. Co., Refractory Materials Research, Quart. Progress Rept. No. 10, 1-34, 1963. [AD 403529], [AD 405520]
113	16963	Riethof, Gen. Elec. Co., Space Sci. Lab., 1-34, 1961. [AD 250274]
114	16423	DeVos, J.C., Physica, 20, 690-714, 1954.
115	9978	Larrabee, R.D., J. Opt. Soc. Am., 49 (6), 619-25, 1959.
116	9364	Lemmon, A.W., BMI-1192, 1-74, 1957.
117	4440	Hole, W.L. and Wright, R.W., Phys. Rev., 56, 785-7, 1939.
118	10931	Furman, S.C. and McManus, P.A., USAEC, GEAP-3338, 1-46, 1960.
119	27371	Maki, A.G. and Plyler, E.K., J. Res. Nat'l. Bur. Std., C66 (3), 283-7, 1962.
120	10168	Rosenbaum, D.M., Sherwood, E.M., Campbell, I.E., Sims, C.T., Craighead, C.M., Jaffee, R.I., Wyler, E.N., and Todd, F.C., BMI, Investigations of Rhenium, Quart. Progress Rept. No. 4, 1-40, 1953. [AD 17543]

Ref. No.	TPRC No.	
121	31729	Bloom, F.K., Metal Progr., 63, 67-72, 1953.
122	29316	Janssen, J.E., Torborg, R.H., Luck, J.R., and Schmidt, R.N., ASD-TR-61-147, 1-269, 1961. [AD 270453]
123	27253	Walin, D.R., Gen. Dynamics Convair, Study of Thermal Insulating Materials, Final Rept., 1-200 1961. [AD 606107]
124	31731	Johnson, B.K., Proc. Phys. Soc. (London), 53, 258-64, 1941.
125	27424	Bennett, H.E., Bennett, J.M., and Ashley, E.J., J. Opt. Soc. Am., 52, 1245-50, 1962. [AD 404995]
126	28940	Dunkle, R.V. and Gier, J.T., Inst. of Eng. Res., Calif. Univ., Berkeley, Progress Rept., 1-73, 1953. [AD 16830]
127	25806	Holland, L. and Williams, B.J., J. Sci. Instr., 32, 287, 1955.
128	24861	Dunkle, R.V., Edwards, D.K., Gier, J.T., Nelson, K.E., and Roddick, R.D., ASME Second Symposium on Thermophysical Properties, Princeton, N.J., 541-62, 1962.
129	36483	Cox, J.T., Hass, G., and Ramsey, J.B., Proc. 1964 Army Sci. Conf., West Point, N.Y., 193-205, 1964. [AD 612134]
130	31933	Pettit, E., Publ. Astron. Soc. Pacific, 46, 27-31, 1934.
131	25561	Porter, J. and Butler, E.A.W., Royal Aircraft Establishment, RAE-TN-S-64, 1-24, 1964. [AD 612164]
132	23741	Coblentz, W.W., Bull. Nat'l. Bur. Std., 7 (2), 197-225, 1911.
133	7159	Wulff, J., J. Opt. Soc. Am., 24, 223-6, 1934.
134	7538	Romanathan, K.G., Nat'l. Bur. Std. Circ., 519, 257-9, 1952.
135	20294	Douglass, R.W. and Adkins, E.F., Trans. Met. Soc. AIME, 221 (2), 248-9, 1961.
136	25436	Gier, J.T., Dunkle, R.V., and Bevans, J.T., J. Opt. Soc. Am., 44 (7), 558-62, 1954.
137	22526	Lowery, H. and Moore, R.L., Phil. Mag., 13, 938-52, 1932.
138	19294	Seban, R.A. and Rolling, R.E., WADD-TR-60-370, 1-110, 1960.
139	23290	Rayne, J.A., Phys. Rev. Letters, 3 (11), 512-4, 1959.
140	7464	Biondi, M.A., Phys. Rev., 96 (2), 534-5, 1954.
141	4687	Bueche, F., J. Opt. Soc. Am., 38, 806-10, 1948.
142	896	Weil, R., Proc. Phys. Soc. (London), 59, 781-91, 1947.
143	22516	Coblentz, W.W. and Stair, R.J., Research, Nat'l. Bur. Std., 2, 343-54, 1929.
144	21573	Crowell, C.R., Spitzer, W.G., Howarth, L.E., and LaBate, E.E., Phys. Rev., 127, 2006-15, 1962.
145	20474	Harris, L. and Fowler, P., J. Opt. Soc. Am., 51 (2), 164-7, 1961.
146	10017	Olson, O.H. and Morris, J.C., WADC-TR-56-222 (Pt 2 Suppl. 1), 1-31, 1958. [AD 202494]
147	10461	Blau, H.H., Jr., Chaffee, E., Jasperse, J.R., and Martin, W.S., AFCRC-TN-60-165, 1-71, 1960. [AD 236394]
148	29595	Edwards, D.K., Gier, J.T., Nelson, K.E., and Roddick, R.D., J. Opt. Soc. Am., 51 (11), 1279-88, 1961.
149	22500	Weniger, W. and Pfund, A.H., J. Franklin Inst., 183, 354-5, 1917.
150	22539	Weniger, W. and Pfund, A.H., Phys. Rev., 14, 427-433, 1919.
151	22523	Coblenz, W.W., Nat'l. Bur. Std. Bull., 16, 249-52, 1920.
152	25234	Waltenburg, R.G. and Coblenz, W.W., Sci. Papers, Nat'l. Bur. Std., 15, 653-7, 1920.
153	29572	Adams, J.G., Northrop Space Labs., Hawthorne, Calif., NSL-62-198, 1-101, 1962.
154	23571	Bevans, J.T., LeVantine, A.D., and Luedke, E.E., Space Tech. Labs. Inc., STL/TR-60-0000-19423, AFBMD-TR-61-12, 1-32, 1960. [AD 255968]
155	16503	Snyder, N.W., Gier, J.T., Dunkle, R.V., and Possner, L., Univ. Calif., Berkeley, 1-16, 1948. [ATI 90576] [PB 142256]
156	16606	Blau, H.H., Jr., March, J.B., Martin, W.S., Jasperse, J.R., and Chaffee, E., AFCRL-TR-60-416, 1-78, 1960. [AD 248276]
157	12280	Boelter, L.M.K., Bromberg, B.R., and Gier, J.T., Univ. Calif., Berkeley, NACA, ARR-4 A21, 1-13, 1944.
158	24808	Cowling, J.E., Alexander, A.L., and Noonan, F.M., WADD-TR-60-773, 17-37, 1961. [AD 267310]

Ref. No.	TPRC No.	
159	29202	Research Projects Div., G. C. Marshall Space Flight Center, Huntsville, Ala., NASA-TN-D-1523, NASA-N63-14272, 1-253, 1963.
160	6596	Wilkes, G.B., WACD-TR-54-42, 1-94, 1954. [AD 88066]
161	8135	Wade, W.R., NASA MEMO 1-20-59 L, 1-30, 1959. [AD 209192]
162	29579	Gordon, A.R. and Muchnik, G.F., High Temperature, 2 (4), 505-8, 1964.
163	4310	Roeser, W.F., Proc. Am. Soc. Testing Materials, 39, 780-7, 1939
164	20772	O'Sullivan, W.J. and Wade, W.R., NASA-TR-T-90, 1-24, 1961.
165	26089	Wade, W.R. and Slemp, W.S., NASA-TN-D-998, 1-35, 1962. [AD 272614]
166	6740	Lemmon, A.W., Jr., USAEC, BMI-1154, 114, 1957.
167	26268	Komarek, A. and Strigin, B.K., High Temperature, 1 (1), 24-6, 1963.
168	6639	Goodman, S., NBS Rept. 4239, 1-13, 1955. [AD 71409]
169	6932	O'Sullivan, W.J., Jr. and Wade, W.R., NACA-TN-4121, 1-48, 1957.
170	8277	Richmond, J.C. and Stewart, J.E., NASA Memo 4-9-59 W, 1-30, 1959.
171	30639	Evans, R.J., Clayton, W.A., and Fries, M., NASA-SP-31, 483-88, 1963.
172	28946	Harrison, W.N., Richmond, J.C., Plyler, E.K., Stair, R., and Skramstad, H.K., WADC-TR-59-510 (Pt 2), 1-21, 1961. [AD 259326]
173	3735	Weil, R., Nature, 159, 305, 1947.
174	759	Knop, H.W., Jr., Phys. Rev., 74, 1413-6, 1948.
175	23134	Muldawer, L., AFOSR-TN-57-667, 1-33, 1957. [AD 136656]
176	4799	Wahlin, H.B., Zentner, R., and Martin, J., J. Appl. Physics, 23 (1), 107-8, 1952.
177	6444	Bossart, P.N., Univ. Pittsburgh Bull. No. 30, 59-64, 1933.
178	31929	Lucks, C.F., Gaines, G.B., Deem, H.W., Wood, W.D., and Nexsen, W.E., Jr., USAEC, BMI-1094 (Del.), 84-6, 1956.
179	12198	Shibata, K., J. Opt. Soc. Am., 47 (2), 172-5, 1957.
180	24537	Gannon, R.E. and Linder, B., J. Am. Ceram. Soc., 47 (11), 592-3, 1964.
181	10060	Olson, O.H. and Morris, J.C., WADC-TR-56-222 (Pt 3), 1-96, 1959. [AD 239302]
182	22272	Schatz, E.A., Goldberg, D.M., Pearson, E.G., and Burks, T.L., ASD-TDR-63-657 (Pt 1), 1-181, 1963. [AD 423743]
183	4200	Patterson, J.R., Trans. Brit. Ceram. Soc., 54, 698-705, 1955.
184	25074	Childers, H.M. and Cerceo, J.M., WADD-TR-60-190, 1-66, 1961. [AD 272691]
185	36236	Laszlo, T.S., Gannon, R.E., and Sheehan, P.J., Solar Energy (USA), 8 (4), 105-11, 1964. [AD 611945]
186	10101	Kingery, W.D. and Norton, F.H., M.I.T., USAEC, NYO-6447, 1-16, 1955.
187	29570	Folweiler, R.C., ASD-TDR-62-719, 1-115, 1964. [AD 600370]
188	3340	Seifert, R.L., Phys. Rev., 73, 1181-7, 1948.
189	28431	Durig, J.R., Lord, R.C., Gardner, W.J., and Johnston, L.H., J. Opt. Soc. Am., 52, 1078, 1962.
190	22518	Burgess. G.K., Nat'l. Bur. Std. Bull., 6, 111-9, 1909.
191	24705	McMahon, W.R. and Wilder, D.R., Ames Lab., Iowa State, USAEC, IS-578, 1-48, 1963.
192	16013	Bailey, P.C. and Goldman, A., AFCRC-TR-60-147, 1-75, 1960. [AD 240236]
193	26852	Kaiser, W., Spitzer, W.G., Kaiser, R.H., and Howarth, L.E., Phys. Rev., 127 (6), 1950-4, 1962.
194	4784	Benford, F., Lloyd, G.P., and Schwarz, S., J. Opt. Soc. Am., 38, 445-7, 1948.
195	31733	Avgustinik, A.I., FTD-TT-63-265, 1-7, 1963. [AD 409701]
196	10967	Mergerian, D., Olson, O.H., and Weigandt, A., ARF-1159, Second Quarterly Progress Rept., 1-8, 1960.
197	12026	Seifert, H.S. and Randall, H.M., Rev. Sci. Instruments, 11, 365-8, 1940.
198	8271	Ehlert, T.C. and Margrave, J.L., J. Am. Ceram. Soc., 41 (8), 330, 1958.
199	24582	Wickersheim, K.A. and Lefever, R.A., J. Opt. Soc. Am., 51, 1147-8, 1961.
200	4837	Mollwo, E., Zangew. Phys., 6, 257-60, 1954.
201	21923	Slemp, W.S. and Wade, W.R., NASA-SP-31, 433-9, 1963.
202	27141	Bogdan, L., NASA-CR-27, NAS 8-823, 1-39, 1964.

Ref. No.	TPRC No.	
203	18429	Gottlieb, M., J. Opt. Soc. Am., 50, 350-1, 1960.
204	33682	Kibler, G.M., Lyon, T.F., Linevsky, M.J., and Desantis, V.J., WADD-TR-60-646 (Pt 4), 1-141, 1964. [AD 606 836]
205	15869	Lowrie, R., Crist, R.H., and Schomaker, V., Union Carbide Res. Inst., Research in Physical and Chemical Principles Affecting High Temperature Materials for Rocket Nozzles, 1-58, 1960. [AD 239 305] [PB 159 273]
206	30773	Samsonov, G.V., Fomenko, V.S., and Paderno, Yu.B., Oyneupory, 27 (1), 49-2, 1962.
207	758	Silverman, S., J. Opt. Soc. Am., 38, 989, 1948.
208	25673	Mitchell, C.A., J. Opt. Soc. Am., 52 (3), 341-2, 1962.
209	20761	Shaffer, P.T.B., Development of Ultra Refractory Materials, Progress Rept. No. 25, 1-4, 1961. [AD 261 461]
210	26949	Grossman, L.N., Hoyt, E.W., Ingold, H.H., Kaznoff, A., and Sanderson, M.J., Gen. Elec. Co., Pleasanton, Calif., GEST-2009, 1-208, 1962. [AD 296 577]
211	18819	Los Alamos Scientific Lab., Quarterly Status Report on the LASL Plasma Thermocouple Development Program for Period Ending March 20, 1961, USAEC, LAMS-2544, 1-15, 1961.
212	23663	Haas, C. and Corbey, M.M.G., J. Phys. Chem. Solids, 20 (3/4), 197-203, 1961.
213	39680	Schleiger, E.R., AFML-TR-66-148, 1-41, 1966. [AD 801 322-L]
214	32537	Stierwalt, D.L. and Potter, R.F., Proc. Intern. Conf. Phys. Semicond., Exeter, Engl., 513-20, 1962.
215	33491	Maki, A.G., Proc. Conf. on Radiative Transfer from Solid Materials, Boston, Mass., 135-41, 1962.
216	29648	Gier, J.T., Possner, L., Test, A.J., Dunkle, R.V., and Bevans, J.T., Calif. Univ., Dept. Eng., USN, NR-05-202, 1-4, 1949. [ATI 59 635]
217	33206	Schmidt, E., Hauzeitschr, V.A.W., and Erftwerk, A.G., Aluminum, 3, 91-6, 1930.
218	30622	Zerlaut, G.A., NASA-SP-31, 275-85, 1963.
219	38391	Edwards, D.K. and Catton, I., From Advances in Thermophysical Properties at Extreme Temperatures and Pressures, 3rd ASME Symp. on Thermophysical Properties, Laf. Ind., 189-99, 1965.
220	36320	Davies, J.M. and Zagieboylo, W., Appl. Opt., 4 (2), 167-74, 1965.
221	37355	Keating, G.M. and Mullings, J.A., NASA-TN-D-2388, 1-45, 1964.
222	24473	Bennett, H.E. and Koehler, W.F., J. Opt. Soc. Am., 50, 1-6, 1960.
223	33512	Leigh, C.H., RAD-TR-62-33, NASA-CR-53235, N64-17590, 1-68, 1962.
224	33287	Taylor, A.H., J. Opt. Soc. Am., 21, 776-84, 1931.
225	38390	Edwards, D.K. and deVolo, N.B., From Advances in Thermophysical Properties at Extreme Temperatures and Pressures, 3rd ASME Symp. on Thermophysical Properties, Purdue Univ., 174-88, 1965.
226	27345	LaBaw, K.B., Olsen, A.L., and Nichols, L.W., Naval Ordnance Test Station, NavWeps 8086, 1-32, 1963. [AD 403 988]
227	35833	Rolling, R.E., Funai, A.I., and Grammer, J.R., USAF, ML-TR-64-363, 1-161, 1964. [AD 466 662]
228	20392	Hagen, E. and Rubens, H., Ann. Physik, 1, 352-75, 1900.
229	33080	Wesolowska, C. and Richard, J., Compt. Rend., 258 (9), 2533-6, 1964.
230	38173	Brekhovskikh, V.F., Inzhen.-Fiz. Zh. (USSR), 7 (5), 66-9, 1964.
231	32234	Spitzer, W.G., Gobeli, G.W., and Trumbore, F.A., J. Appl. Phys., 35 (1), 206-11, 1964.
232	38629	Richard, J., Compt. Rend., 256 (5), 1093-5, 1963.
233	18520	Philip, R., J. Phys. Radium, 20, 535-40, 1959.
234	15016	Philip, R., Compt. Rend., 247 (25), 2322-4, 1958.
235	20474	Harris, L. and Fowler, P., J. Opt. Soc. Am., 51 (2), 164-7, 1961.
236	34758	Shaw, M.L., J. Appl. Phys., 37 (2), 919-20, 1966.
237	36161	Tingwaldt, C., Schley, U., Verch, J., and Takata, S., Optik, 22 (1), 48-59, 1965.
238	30957	Naumann, V.O., Univ. of Wisc., PhD. Thesis, 1-23, 1956.
239	30838	Metzger, J.W., Drexel Inst. of Tech., M.S. Thesis, 1-115, 1959.
240	35988	Davey, J.E. and Pankey, T., J. Appl. Phys., 36 (8), 2571-6, 1965.
241	23414	Martin, W.S., Duchane, E.M., and Blau, H.H., Jr., AFCRL-63-547, 1026, 1963. [AD 428 932]
242	26461	Loferski, J.J., Univ. of Penn., Semi-Conductor Res., Quarterly Rept. No. 3, 1-59, 1953. [AD 14 711] [PB 160 835]

Ref. No.	TPRC No.	
243	36689	Rabinovich, K., Canfield, L. R., and Madden, R. P., Appl. Opt., 4 (8), 1005-10, 1965.
244	30611	Hembach, R. J., Hemmerdinger, L., and Katz, A. J., NASA-SP-31, 153-67, 1963.
245	36942	Seban, R. A., J. Heat Transfer ASME, C87 (2), 173-6, 1965.
246	40949	Jain, S. C., Goel, T. C., and Chandra, I., Phys. Letters, 24A (6), 320-1, 1967.
247	31791	Birkebak, R. C., Sparrow, E. M., Eckert, E. R. G., and Ramsey, J. W., Trans. ASME, 86C (2), 193-99, 1964.
248	32639	Lapina, E. A. and Chudnovskii, F. A., High Temperature (USSR), 3 (5), 639-42, 1965.
249	30472	Birkebak, R. C., M.S. Thesis, Univ. Minnesota, 1-27, 1956.
250	40866	Voskressenskii, V. Yu., Peletskii, V. E., and Timrot, D. L., High Temperature, 4 (1), 39-42, 1966.
251	12687	Malé, D. and Trompette, J., J. Phys. Radium, 18 (2), 128-30, 1957.
252	36503	Alvares, N. J., NASA-SP-55, 183-7, 1965.
253	22542	Davisson, C. and Weeks, J. R., Phys. Rev., 17, 261-3, 1921.
254	21284	Harrison, W. N., Richmond, J. C., Shorten, F. J., and Joseph, H. M., WADC-TR-59-510 (Pt 4), 1-90, 1963. [AD 426 846]
255	30353	Kollie, T. G. and McElroy, D. L., Oak Ridge Nat'l. Lab., USAEC, ORNL-3670, 109-11, 1964.
256	30379	Gaines, G. B. and Sims, C. T., J. Appl. Phys., 34 (9), 2922, 1963.
257	35334	Vasko, A., Czechoslov. J. Physics, 15 (3), 170-7, 1965.
258	32456	Eckart, F. and Henrion, W., Monatsber. Deutschen Akad. Wiss., Berlin, 4 (7), 440-51, 1962.
259	32340	Kuharskii, A. A. and Subashiev, V. K., Soviet Physics-Solid State, 8 (3), 603-6, 1966.
260	40955	Koltun, M. M. and Golovner, T. M., Opt. Spectr'y, 21 (5), 347-50, 1966.
261	29605	Howarth, L. E. and Gilbert, J. F., J. Appl. Phys., 34, 236-7, 1963.
262	40599	Rudyavskaya, I. G., Kurdryavtseva, A. G., and Kislovskii, L. D., Opt. Spectr'y, 21 (4), 266-9, 1966.
263	8386	Trompette, J., Comptes Rendus, 246, 753-6, 1958.
264	31619	Raub, E. and Engel, M., Z. Metallk., 31 (11), 339-44, 1939.
265	38766	Valeev, A. S. and Gisin, M. A., Opt. Spectr'y, 19 (1), 62-5, 1965.
266	24388	Wesolowska, C., Compt. Rend., 258 (21), 5191-4, 1964.
267	38987	Jun, C. K. and Hoch, M., AFML-TR-65-191, 1-11, 1965. [AD 477 224]
268	41008	Seemuller, H. and Stark, D., Z. Physik, 198 (2), 201-4, 1967.
269	29596	Dunkle, R. V., Edwards, D. K., Gier, J. T., and Bevans, J. T., Solar Energy, 4 (2), 27-39, 1960.
270	30750	Malek, G. J., Univ. of Calif., M.S. Thesis, 1-145, 1962.
271	16433	Worthing, A. G. and Forsythe, W. E., Phys. Rev., 18, 144-7, 1921.
272	32539	Langmuir, I., Phys. Rev., 7 (3), 302-30, 1916.
273	29638	Engelke, W. T. and Pears, C. D., Southern Research Inst., SRI-5465-1419-I, 1-10, 1962. [AD 459 521]
274	37801	Deadmore, D., J. Am. Ceram. Soc., 47, 649-50, 1964.
275	16298	Worthing, A. G., J. Opt. Soc. Am., 13, 635-49, 1926.
276	31931	Cubicciotti, D., J. Am. Chem. Soc., 73, 2032-5, 1951.
277	30766	Baker, L., Jr., Mouradian, E. M., and Bingle, J. D., Nucl. Sci. Eng., 15, 218-20, 1963.
278	16009	Noonan, F. M., Alexander, A. L., and Cowling, J. E., NRL Rept. 5503, 1-39, 1960. [AD 240 141]
279	35821	DeSantis, V. J., Gen. Elec. Co., Missile and Space Div., Rept. No. R64 SD60, 1-30, 1964. [AD 466 356]
280	24826	McDonough, R., First Symposium on Surface Effects on Spacecraft Materials, John Wiley and Sons, Inc., 141-51, 1960.
281	41003	Mitor, V. V. and Konopel'Ko, L. N., Thermal Engineering, 13 (7), 92-7, 1966.
282	34454	Brandenberg, W. M., Clausen, O. W., and McKeown, D., J. Opt. Soc. Am., 56 (1), 80-6, 1966.
283	37595	Minura, T., Anagnostou, E., and Colarusso, P. E., NASA-TN-D-3234, 1-56, 1966.
284	33623	Clavier, J., Rev. Optique, 8, 379-91, 1929.
285	33241	Bennett, H. E., Proc. Conf. on Radiative Transfer from Solid Materials, MacMillan Co., N. Y., 166-80, 1962.
286	32538	Biondi, M. A. and Rayne, J. A., Phys. Rev., 115 (6), 1522-30, 1959.

Ref. No.	TPRC No.	
287	44279	Biondi, M.A., Phys. Rev., 102 (4), 964-67, 1956.
288	20810	Gillespie, G.T., Olsen, A.L., and Nichols, L.W., NAVWEPS Rept. 8558, NOTS-TP-3586, 1-28, 1964. [AD 609 036]
289	40152	Husmann, O.K., J. Appl. Phys., 37 (13), 4662-70, 1966.
290	44300	Hunter, W.R., Optical Properties and Electronic Structure of Metals and Alloys, North-Holland Pub. Co., Amsterdam, 136-46, 1966.
291	38325	Petrov, V.A., Checkovskoi, V.Ys., and Sheindlin, A.E., High Temperature (USSR), 1 (3), 416-18, 1963.
292	38726	Clark, H.E., Appl. Opt., 4 (10), 1356-7, 1965.
293	33882	Muller, W.E., Appl. Opt., 5 (5), 876-7, 1966.
294	37539	Howl, D.A. and Davis, A.F., Iron and Steel Institute, J., 202, 523-6, 1964.
295	30625	Funai, A.I., NASA-SP-31, 317-27, 1963.
296	18661	Richmond, J.C. and Harrison, W.N., Am. Ceramic Soc. Bull., 39, 668-73, 1960.
297	32493	Wessel, P.R., Phys. Rev., 132 (5), 2062-4, 1963.
298	26751	Richmond, J.C., DeWitt, D.P., and Hayes, W.D., Jr., NBS-TN-252-ML-TDR-64-257, 55, 1964. [AD 612 812]
299	31957	de L'Estoile, H. and Rosenthal, L., Advisory Group for Aeronautical Research and Development, Paris, France, AGARD-211, N63-21549, 1-82, 1958.
300	31794	Lucks, C.F., Gaines, G.B., Deem, H.W., Wood, W.D., and Nexsen, W.E., Jr., USAEC, BMI-1088, 66-7, 1956.
301	39182	Sambongi, T., Hagiwara, R., and Yamadaya, T., J. Phys. Soc. Japan, 21 (5), 923-5, 1966.
302	10649	Grenis, J.A. and Wong, K., Watertown Arsenal, WAL TR 397.1/1, 11, 1958. [AD 201 488]
303	32538	Biondi, M.A., Phys. Rev., 102 (4), 964-67, 1956.
304	16590	Fieldhouse, I.B., Lang, J.I., and Blau, H.H., Jr., WADC-TR-59-744, 4, 1-78, 1960. [AD 249 166]
305	25754	Bradley, D. and Entwistle, A.G., British J. Appl. Phys., 12 (12), 708-11, 1961.
306	32363	Hass, G. and Tousey, R., J. Opt. Soc. Am., 49 (6), 593-602, 1959.
307	32388	Byrne, R.F. and Mancinelli, L.N., Material Lab., N.Y. Naval Shipyard, 39, 1954. [PB 159 155]
308	36346	Rustgi, Om. P., J. Opt. Soc. Am., 55 (6), 630-4, 1965.
309	39977	Fisher, E.I., Fujita, I., and Weissler, G.L., J. Opt. Soc. Am., 56 (11), 1560-4, 1966.
310	34548	Jelinek, T.M., Hamm, R.N., Arakawa, E.T., and Huebner, R.H., J. Opt. Soc. Am., 56 (2), 185-6, 1966.
311	39976	Henderson, G. and Weaver, C., J. Opt. Soc. Am., 56 (11), 1551-9, 1966.
312	28197	Lowery, H., Wilkinson, H., and Smare, D.L., Phila. Mag., 22, 769-90, 1936.
313	33099	Ehrenreich, H. and Philipp, H.R., Phys. Rev., 128 (4), 1622-9, 1962.
314	33896	Torrance, K.E. and Sparrow, E.M., Trans. ASME, J. Heat Transfer, 88C (2), 223-30, 1966.
315	38254	Canfield, L.R. and Hass, G., J. Opt. Soc. Am., 55 (1), 61-4, 1965.
316	44307	Schuler, C.Chr., Optical Properties of Electronic Structure of Metals and Alloys, North-Holland Pub. Co., Amsterdam, 221-36, 1966.
317	32673	Anderson, A.E., Univ. of Calif., M.S. Thesis, 1-57, 1962.
318	32880	Russell, A.D., Univ. of Calif., M.S. Thesis, 1-47, 1960.
319	24665	Philipp, H.R. and Taft, E.A., Phys. Rev., 113 (4), 1002-5, 1959.
320	39215	Rideout, V.L. and Wemple, S.H., J. Opt. Soc. Am., 56 (6), 749-51, 1966.
321	28015	Braner, A.A. and Chen, R., J. Phys. Chem. Solids, 24, 135-9, 1963.
322	40221	Hass, G., Jacobus, G.F., and Hunter, W.R., J. Opt. Soc. Am., 57 (6), 758-62, 1967.
323	39975	Barnes, T.B., J. Opt. Soc. Am., 56 (11), 1546-50, 1966.
324	17329	Brandt, J.A., Irvine, T.F., Jr., and Eckert, E.R.G., Proc. Heat Trans. Fluid Mech. Inst., Stanford Univ., 220-7, 1960.
325	26230	Krzhizhanovskii, B.A., Kolchenogova, I.P., and Rakov, A.M., High Temperature, 1 (1), 13-18, 1963.
326	26832	Sasaki, T. and Ishiguro, K., Phys. Rev., 127, 1091-2, 1962.
327	26044	Vavilov, V.S. and Galkin, G.N., Fiz. Tverdogo Tela, 1, 1201-4, 1959.

Ref. No.	TPRC No.	
328	42006	Peletskii, V.E. and Voskresenskii, V.Yu., High Temperature, 4 (3), 329-33, 1966.
329	34549	Codling, K., Madden, R.P., Hunter, W.R., and Angel, D.W., J. Opt. Soc. Am., 56 (2), 189-92, 1966.
330	25167	Coblentz, W.W., Bull. Nat'l. Bur. Std., 14, 307-16, 1917.
331	27822	Hulburt, E.O., Astrophys. J., 45, 149-63, 1917.
332	39978	Cairns, R.B. and Samson, J.A.R., J. Opt. Soc. Am., 56 (11), 1568-73, 1966.
333	25454	Good, R.C., Jr., Space Sciences Lab., General Electric Co., AFOSR-5096, 1-80, 1963. [AD 413 974]
334	38942	Timrot, D.L. and Peletskii, V.E., High Temperature, 3 (2), 199-202, 1965.
335	41741	Peletskii, V.E. and Voskrenskii, V.Yu., High Temperature, 4 (2), 293-4, 1966.
336	40413	Schocken, K. and Fountain, J.A., Proc. of Conf. on Spacecraft Coatings Development, NASA-TM-X-56167, 20, 1964.
337	35223	Cairns, R.B. and Samson, J.A.R., J. Opt. Soc. Am., 57 (3), 433-4, 1967.
338	39369	Dmitriev, V.D. and Kholopov, G.K., Zh. Prikl. Spektrosk., Akad Nauk. Belorussk, SSR, 2 (6), 481-8, 1965.
339	39439	Grant, P.M. and Paul, W., J. Appl. Phys., 37 (8), 3110-20, 1966.
340	28621	Coblentz, W.W., Phys. Rev., 30 (5), 645-7, 1910.
341	42894	Vehse, R.C., Arakawa, E.T., and Stanford, J.L., J. Opt. Soc. Am., 57 (4), 551-2, 1967.
342	31937	Gordon, G.D., Rev. Sci. Instr., 31 (11), 1204-8, 1960.
343	37418	Landensperger, W. and Stark, D., Z. Physik, 180 (2), 178-83, 1964.
344	32449	Bennett, H.E., J. Opt. Soc. Am., 53 (12), 1389-94, 1963.
345	43899	Kunyrina, L.I. and Titkov, A.S., High Temperature, 4 (3), 394-8, 1966.
346	44061	Timrot, D.L., Peletskii, V.E., and Voskresenskii, V.Yu., High Temperature (USSR), 4 (6), 808-9, 1966.
347	44308	Blodgett, A.J., Jr., Spicer, W.E., and Yu, A.Y.C., Optical Properties and Electronic Structure of Metals and Alloys, North-Holland Pub. Co., Amsterdam, 246-56, 1966.
348	44310	Sasaki, T. and Ejiri, A., Optical Properties and Electronic Structure of Metals and Alloys, North-Holland Pub. Co., Amsterdam, 417-27, 1966.
349	36342	Rustgi, Om. P. and Weissler, G.L., J. Opt. Soc. Am., 55 (4), 456, 1965.
350	44314	Fukutani, H. and Sueoka, O., Optical Properties and Electronic Structure of Metals and Alloys, North-Holland Pub. Co., Amsterdam, 565-73, 1966.
351	33490	Martin, W.S., Proc. Conf. on Radiative Transfer from Solid Materials, MacMillan Co., 123-32, 1962.
352	35744	Anderson, D.L., Trans. Nat'l. Vacuum Syp., 10, 37-41, 1963.

APPENDIX E

TPRC - Information Center for Thermophysics Research

1.0 Introduction

The overall activities of the Thermophysical Properties Research Center (TPRC) are divided into four areas: namely, (1) Scientific Documentation, (2) Generation of Data Tables, (3) Experimental Research, and (4) Theoretical Research. Since 1957, TPRC has contributed much to the knowledge of the thermophysical properties of pure and engineering materials [4]. Its results are disseminated at large in the form of two major publications: the Retrieval Guide and the Data Book.

Previously, the Retrieval Guide was published by McGraw-Hill Book Co., Volume 1 in 1960 and Volume 2 in 1963. Early in 1967, as Volume 3 of the Retrieval Guide was nearing completion, it was decided to publish a single comprehensive volume of this work thus merging the earlier Volumes 1 and 2 with the completed Volume 3. This merged, revised, and enlarged edition of the Retrieval Guide (THERMOPHYSICAL PROPERTIES RESEARCH LITERATURE RETRIEVAL GUIDE) was published in October 1967 by the Plenum Publishing Corporation. This definitive work contains a complete coverage of the world literature published from 1920 (in many cases earlier) to June 1964 on thirteen thermophysical properties. Its 2,800 pages (in 3 books) report 45,116 materials, citing 33,700 references representing 26,562 authors and 3,600 separate scientific and technical journals and books in addition to Government reports. Thus, the new Retrieval Guide brings to the scientific and technical community a single reference work heretofore thought impractical to generate. Effective with the completion of this work, the scope of coverage of the Retrieval Guide has been increased to sixteen properties. Furthermore, each property is coded separately instead of by groups.

The TPRC Data Book brought together the available data on the thermophysical properties of materials to provide for engineers and scientists the most comprehensive and authoritative reference data sources. Whenever possible, the recommended "most probable values" of particular properties for particular materials are also included. The original Data Book consisted of loose-leaf data sheets (11" x 17" in size) organized into three volumes. The data sheets constituted the final formal outlet of all TPRC data tables activities on all of its programs. As of December 1966, the Data Book contained 3,322 sheets, reporting 11,425 test specimens and citing 3,424 references.

In view of the continuing rapid growth of this work since 1960, and the extensive physical proportions it has assumed, early in 1967 it was decided to discontinue the procedure of publication in loose-leaf format, and its semi-annual dissemination by TPRC.

Instead, this Data Book is now restructured and extensively revised and will soon be available through a commercial publisher in the form of formal hard-bound volumes grouped by properties. This forthcoming publication is entitled TPRC SERIES ON THERMOPHYSICAL PROPERTIES OF MATTER.

The information processing and data processing for preparing the Retrieval Guide and the Data Book and the status of the various active projects are outlined briefly in the following sections. The activities of Data Tables Division pertaining to the generation of data tables on thermal radiative properties have been described in the text of this report.

2.0 Scientific Documentation

2.1 Literature Search and Information Processing

The Scientific Documentation Division of TPRC provides comprehensive and authoritative source information on the thermophysical properties of all matter through continuing and systematic search, collection, organization, and codification of the existing information in the world literature. From 1957 to 1964 TPRC has searched the world literature primarily through the abstracting journals. Since 1965, TPRC has subscribed to some 80 scientific and technical journals in addition to the abstracting journals, and accordingly, literature search has since been made on both of these two types of journals.

The abstracting journals searched from 1957 to 1964 are listed in Table E-1. This search, covering the period from 1920 to June 1964, involved the scanning of approximately 33,400,000 abstracts out of approximately 81,000,000 abstracts reported by these journals. Out of the 33,400,000 abstracts scanned, only 52,500 (0.16%) were considered pertinent. Subsequent examination and checking of the 52,500 abstracts and the original papers revealed a large number of duplications between the various abstracting journals and nearly 9,900 irrelevant ones, leaving a net total of 28,800 documents obtained from these sources. In addition to abstracts, 4,900 documents came to TPRC's attention from other sources making a total of 33,700

TABLE E-1. WORLD COVERAGE OF RESEARCH LITERATURE ON THERMOPHYSICAL PROPERTIES THROUGH THE EYES OF 16 ABSTRACTING JOURNALS

(As of December 31, 1964)

ABSTRACTING JOURNALS	COVERAGE
Applied Mechanics Review (AM)	Jan. 1948 to June 1964
ASM Review of Current Metal Literature (in Metals Review) (MR)*	Jan. 1957 to Aug. 1959
ASM Review of Metal Literature (RM)	Jan. 1944 to Dec. 1955 and Jan. 1959 to June 1964
Battelle Technical Review (BR)	Feb. 1957 to June 1964
Ceramics Abstracts-Amer. Ceramic Soc. (JA)	Jan. 1957 to June 1964
Ceramics Abstracts-Brit. Ceramic Soc. (BA)	Jan. 1958 to June 1964
Chemical Abstracts (CA)	Jan. 1920 to June 1964
Masters Theses in the Pure and Applied Sciences - TPRC(MT)	1957 to 1964
Metallurgical Abstracts, Series II (MA)	Jan. 1934 to Aug. 1956 and Sept. 1958 to June 1964
Nuclear Science Abstracts (NA)	Jan. 1963 to June 1964
Physics Abstracts (SA)	Jan. 1957 to June 1964
Refrigeration Abstracts (RA)	Jan. 1946 to Oct. 1957
Scientific and Technical Aerospace Reports-NASA (PA)	Jan. 1957 to June 1964
Technical Abstract Bulletin-DDC (TA)*	Jan. 1957 to June 1964
Technical Translations-CFSTI (TT)*	Jan. 1957 to June 1964
U.S. Government Research Reports-CFSTI (RR)	Jan. 1957 to June 1964

*Ceased publication

documents up to June 1964. These 33,700 references are covered in the revised and expanded edition of the Retrieval Guide.

Subsequently, in preparation for the future volume of the Retrieval Guide, an additional 17,300 reference entries have been made. Thus, as of 31 December 1968 there were 51,000 references in TPRC's Information storage and Retrieval System. The above figure gives an insight as to the magnitude of the effort involved in a thorough search of world knowledge even in a relatively specialized field.

When the retrospective search of the world literature, primarily through the medium of abstracting journals, was completed early in 1956, TPRC reviewed its procedure of using abstracting journals for the identification of current literature on thermophysical properties research. It was recognized that continued use of abstracting journals for research awareness would represent, at best, one to two years of delay in identifying and procuring such literature, with the result that bibliographic searches provided by TPRC could never be on a reasonably current basis. A statistical study was made of the data accumulated at TPRC concerning the yield of 3,600 technical and scientific journals cited to date, and it was found that some 80 journals yielded approximately 50 percent of the total articles. Hence, effective January 1965, TPRC subscribed to these journals and began its search directly from these publications. Simultaneously, with the adoption of this procedure, the effort in searching abstracting journals was reduced, by 1967, to seven abstracting journals: Chemical Abstracts, Dissertation Abstracts, International Aerospace Abstracts, Nuclear Science Abstracts, Scientific and Technical Aerospace Reports-NASA, Technical Abstract Bulletin, and U.S. Government Research and Development Reports. As a result of this policy, TPRC is now able to keep abreast of published research results with an average time lag not to exceed six months.

The problem of procuring research documents from the open literature is beginning to assume major proportions especially in the case of foreign literature and special publications of limited distribution. Therefore, TPRC's specialized holdings, which number 35,800 to data, are assuming increasing importance for rapid access to the world literature on thermophysics and thermophysical properties. It is TPRC's experience that literature retrieval programs which yield bibliographies as their end product are becoming increasingly less useful because of the time lapse involved in

procuring the cited documents. In an attempt to remedy this situation, TPRC has supplemented its long-standing practice of submitting bibliographic responses to literature search requests with standard microfiche copies of documents. The conversion of hard copy document holdings into microfiche was completed in 1967.

2.2 The Retrieval Guide

The comprehensive edition of the THERMOPHYSICAL PROPERTIES RESEARCH LITERATURE RETRIEVAL GUIDE was published in October 1967 by the Plenum Publishing Corporation [1].

This three-book volume represents the printout of a special computer program and provides quick access to world literature on thirteen thermophysical properties of all matter. Its substance and property coverage are listed in Table E-2.

This volume completes the coverage of the world literature published from 1920 (in some cases earlier) to June 1964 on thirteen thermophysical properties. It is a merger of the material contained in the earlier Volumes 1 and 2 together with the material of Volume 3 which was not published separately. The contents of the three books of the Retrieval Guide are as follows:

Book 1 - Primarily constitutes TPRC's classified Directory of Substances in which information on the thirteen thermophysical properties are reported. Book 1 also contains three other major chapters which greatly enhance its usefulness. These consist of: (1) Guide to TPRC Substance Classification Procedure and Numerical Codes; (2) Dictionary of Synonyms and Trade Names with a Listing of Cross References; and (3) Index to Mixtures.

Book 2 - Contains the classified code entries and publication year of each reference for each property of each material. The classified code entries cover the following:

Phys. State:	1-Solid; 2-Liquid; 3-Gas; 4-Semi-solid; 5-Powder; 6-Suspensoid; 7-Sintered; 8-Solid-Gas system; 9-Solid-Liquid system.
Subject:	1-Theoretical; 2-Experimental; 3-Theo. and Exp.; 4-Property values; 5-Theo. and Prop. val.; 6-Exp. and Prop. val.; 7-Theo., Exp., and Prop. val.; 8-Survey, Review, Compendia, or Bibliography.
Language:	1-Eng.; 2-Fr.; 3-Ger.; 4-Dutch; 5-It.; 6-Jap.; 7-Rus.; 8-Span.; 9-Other.
Temperature:	1-Low, 0 to 75 K; 2-Normal, 75 to 1275 K; 3-High, 1275 K and up; 4-(Low+Normal); 5-(Normal+High); 6-(Low+Normal+High); 7-Not specific

TABLE E-2. SUBSTANCE AND PROPERTY COVERAGES OF RETRIEVAL GUIDE*

SUBSTANCE COVERAGE - All Matter	
Elements and chemical compounds	9,030
Ferrous and nonferrous alloys	9,970
Mixtures	13,396
Systems, composites, etc.	1,643
Polymers, rubbers, etc.	2,600
Refractories	961
Glasses	1,109
Natural products	1,100
Minerals	662
Paints, surface finishes, coatings	2,632
Slags, scales, aggregates, cermets, fuels, lubricants, fibers, fabrics, pharmaceuticals, insulations, building materials, residues, etc.	1,967
General	46
Total number of substances	45,116

PROPERTY COVERAGE - Transport and Thermodynamic Properties Encountered in Heat and Mass Transfer Calculations	
Thermal conductivity (including commodation coefficient and thermal contact resistance)	31,050
Specific heat	28,020
Viscosity (Newtonian and non-Newtonian; including fluidity)	46,870
Thermal radiative properties (Emittance, reflectance, absorption, transmittance, and optical constants)	9,400
Diffusion coefficient	21,720
Thermal diffusivity	1,705
Prandtl number	504
Total number of reference entries	139,305

* This storehouse of information has come from 33,700 references representing 26,562 authors and 3,600 separate scientific and technical journals and books in addition to sources of governmental and industrial reports (e.g., Defense Documentation Center, Clearinghouse for Federal Scientific and Technical Information, Atomic Energy Commission, National Aeronautics and Space Administration, research centers, and the like).

Book 3 - Part A provides bibliographic citations for the 33,700 references covering scientific and technical journals in addition to university dissertations and technical reports of governmental agencies, industrial organizations, and research centers and laboratories. Part B contains an index to names of contributing authors.

In January 1967, the scope of property coverage was increased to include the coefficients of linear and volumetric thermal expansion and surface tension. Furthermore, each thermophysical property is coded separately instead of by groups. For instance, the thermal conductivity, accommodation coefficient, and thermal contact resistance, formerly all coded under the property " thermal conductivity", are now coded separately. Similarly, the five entries under thermal radiative properties are now listed separately. Thus, since January 1967 TPRC maintains coverage of over sixteen thermophysical properties for all materials. They are:

1. Thermal conductivity
2. Accommodation coefficient
3. Thermal contact resistance
4. Thermal diffusivity
5. Specific heat at constant pressure
6. Viscosity
7. Emittance
8. Reflectance
9. Absorptance
10. Transmittance
11. Absorptance to emittance ratio
12. Prandtl number
13. Diffusion coefficient
14. Thermal linear expansion
15. Thermal volumetric expansion coefficient
16. Surface tension

2.3 Automation and Computerized Information Storage and Retrieval System

With the installation of the CDC 6500 computer at Purdue University in Summer 1967, TPRC's long-standing need for a remote-accessed time-shared computer capability has been fulfilled. As a result, TPRC now has a fully automated bibliographic search capability to respond to specific inquiries or to process standing requests for a continuing bibliographic service tailored to meet demands for specific technical profiles of individual engineers, scientists, corporations, or laboratories.

Since 1968, TPRC has generated, quarterly, a miniature "Retrieval Guide" for each property in order to serve its own inhouse programs. This service, called the UPDATE PLAN, is also available to subscribers at a very nominal cost.

3.0 Data Tables Projects [2]

3.1 Data Book

Synthesis of existing fragments of knowledge is as important as so-called original observation. The availability of adequate standard reference tables of numerical data is essential to national progress, economy, and defense.

The three-volume loose-leaf 11" x 17" size TPRC Data Book is well known nationally and, indeed, internationally as the most comprehensive and authoritative reference data source of its kind. In view of this work's continuing rapid growth since 1960, and the extensive physical proportions it has assumed, early in 1967 it was decided to discontinue the present procedure of publication in loose-leaf format and its semi-annual dissemination by TPRC. Instead, this Data Book was restructured and extensively revised and will soon be available through a commercial publisher in the form of formal hard-bound volumes. The forthcoming publication is entitled TPRC SERIES ON THERMOPHYSICAL PROPERTIES OF MATTER and will be described in more detail later.

The last supplement of the data sheets in the loose-leaf format was that of December 1966. All the available sets of the loose-leaf Data Book were exhausted by mid-year 1967. The data sheets produced during 1967 were held in abeyance and will be released for the first time in the forthcoming Series. It is anticipated that the new volumes will become available according to the tentative schedule presented subsequently.

The changeover from the loose-leaf TPRC publication to formal commercial publication has entailed a number of considerations. Significant among these were the following:

1. The Data Book was to be reduced from its unconventional 11" x 17" dimensions to 9-1/4" x 11-1/4" with printing back to back.
2. The organization of the contents were completely restructured in order to improve user's convenience. The new series is organized into volumes by properties.

3. In order to obviate the cumbersome merging of supplements and the associated high cost of dissemination, it was decided that each edition of a volume will be updated, revised and enlarged approximately every five years.

4. For those who have need for the most up-to-date information, TPRC will provide specific inquiry service or one may subscribe to the automatic UPDATE PLAN tailored to meet a specific technical profile of an engineer, scientist, corporation, or laboratory.

The above-outlined procedure closely parallels the concept which TPRC has followed during the past ten years for the dissemination of bibliographic information. That is, the major accomplishments are published in formal volumes through commercial channels while TPRC disseminates materials to maintain its publications and audience on a current basis.

3.2 TPRC Series on Thermophysical Properties of Matter

Table E-3 gives an indication of the structure, scope, and publication schedule of the forthcoming TPRC SERIES ON THERMOPHYSICAL PROPERTIES OF MATTER. As shown in Table E-3, to be published in 1969 are Volumes 1 through 8, on which a further summary of statistical data is given in Table E-4.

Each volume of the series comprises three sections: the first section is a text on the theory, estimation, and measuremnt of the property, the second section presents the available numerical data for the property of the materials, and the third section is a comprehensive material index.

The following brief summaries will serve to characterize each of the active data tables projects.

3.3 Projects

a. Thermal Radiative Properties (Emittance, Reflectance, Absorptance, and Transmittance)

This group of properties constitutes Volumes 7, 8, and 9 of the new TPRC SERIES. Only Volume 7 (Metallic Elements and Alloys) has now been finished and is ready for publication.

The present tables are organized in a way that is much different from that in the original TPRC Data Book. This is due to the establishment of a new scheme for the designation and categorization of the sub-properties. According to the new scheme, by applying the proper geometric and wavelength descriptors to the prime properties, there are altogether thirty-three sub-properties for any material.

TABLE E-3. PUBLICATION SCHEDULE FOR
TPRC SERIES ON THERMOPHYSICAL PROPERTIES OF MATTER*

		1969	1970	1971	1972	1973	1974	1975	1976	1977
Volume 1.	Thermal Conductivity of Metallic Elements and Alloys	1565				Second Edition				
Volume 2.	Thermal Conductivity of Nonmetallic Solids	1255				Second Edition				
Volume 3.	Thermal Conductivity of Nonmetallic Liquids and Gases	640				Second Edition				
Volume 4.	Specific Heat of Metallic Metallic Elements and Alloys	825					Second Edition			
Volume 5.	Specific Heat of Nonmetallic Solids	1720					Second Edition			
Volume 6.	Specific Heat of Nonmetallic Liquids and Gases	390					Second Edition			
Volume 7.	Thermal Radiative Properties of Metallic Elements and Alloys	1650						Second Edition		
Volume 8.	Thermal Radiative Properties of Nonmetallic Solids	880						Second Edition		
Volume 9.	Thermal Radiative Properties of Coatings		1690					Second Edition		
Volume 10.	Thermal Diffusivity		500						Second Edition	
Volume 11.	Viscosity		400						Second Edition	
Volume 12.	Thermal Expansion of Metallic Elements and Alloys			500						Second Edition
Volume 13.	Thermal Expansion of Nonmetallic Solids			500						Second Edition

*The publication schedule shown in the table gives the estimated number of pages for the first edition and the years in which the volumes are to be published. After the second edition, subsequent editions of each volume will be released at intervals of five years.

TABLE E-4. SUMMARY OF STATISTICAL DATA ON VOLUMES 1 TO 7 OF "TPRC SERIES ON THERMOPHYSICAL PROPERTIES OF MATTER"

		No. of Pages*	No. of Curves	No. of References**
Volume 1.	Thermal Conductivity of Metallic Elements and Alloys	1565	5539	1013
Volume 2.	Thermal Conductivity of Nonmetallic Solids	1255	4627	598
Volume 3.	Thermal Conductivity of Nonmetallic Liquids and Gases	640	1505	725
Volume 4.	Specific Heat of Metallic Elements and Alloys	825	1186	428
Volume 5.	Specific Heat of Nonmetallic Solids	1720	1009	449
Volume 6.	Specific Heat of Nonmetallic Liquids and Gases	390	863	595
Volume 7.	Thermal Radiative Properties of Metallic Elements and Alloys	1650	5309	352

* Estimated

** These are the references to data sources only, not including those references to the text on the theory, estimation, and measurement of the respective thermophysical properties.

Since Volume 7 is now essentially finished, the major efforts are concentrated on the processing of data on coatings and nonmetallic solids so that Volumes 8 and 9 can be published in 1969 and 1970 respectively. The new classification scheme for coatings is now "finalized" after considerable study by the TPRC staff in consultation with several national experts.

Although in Volume 3 of the Retrieval Guide there are only 2,829 references on thermal radiative properties (8.4 percent), in recent years the number of new research documents on the thermal radiative properties has increased steadily and rapidly. Presently, TPRC's acquisition rate is about 6,000 papers per year, 20 percent related to radiative properties. Also, 50 percent of the papers pertaining to radiative properties contain information on coatings. Therefore, it is a very arduous task just to remain current by processing the incoming documents, 1,200 per year, and it has become a standing practice to try to finish the data processing for the most current research documents first, and then to work backwards on the earlier documents. A similar situation is present in the thermal conductivity and specific heat projects.

b. Thermal Conductivity

Thermal conductivity constitutes Volumes 1, 2, and 3 of the new TPRC SERIES. Data compilation for the thermal conductivity of the elements is totally completed and is being maintained on a current basis.

In Volume 3 of the Retrieval Guide, which contains 33,700 references, there are 7,329 references on thermal conductivity, i.e., 21.7 percent (neglecting the relatively small number of references on accommodation coefficient and thermal contact resistance). The present rate of document input into TPRC's Information Storage and Retrieval System is about 6,000 per year. If the past ratio remains the same, there will be 1,300 new documents per year on thermal conductivity entering the System.

In the forthcoming Volumes 1, 2, and 3 of the TPRC SERIES, the thermal conductivity of all metals and alloys, which are organized into seven groups, are included in Volume 1. Volume 2 presents data for thirty groups of nonmetallic solids. Volume 3 contains the critically evaluated and recommended values for 58 fluids which are organized into four groups; for the elements recommended

values are given for solid, saturated liquid, saturated vapor, and gaseous states while for the other three groups of fluids recommended values are given for saturated liquid and gaseous states only.

The three volumes on thermal conductivity contain 2,287 references to data sources. Past experience indicates that only one out of three to four earlier research documents and only one out of two to three more recent documents contains original experimental data. Therefore, to have 2,287 references to data sources, over 7,000 research documents must have been processed.

c. Specific Heat

Specific heat constitutes Volumes 4, 5, and 6 of the new TPRC SERIES. Tables on the specific heat of the elements and of all the important alloys, compounds, and mixtures have been prepared. Data compilation on the specific heat of metallic elements and alloys and nonmetallic solids has been done here at TPRC while the work on nonmetallic liquids and gases has been done at TPRC's Overseas Branch in Japan.

The specific heat of all metals and alloys, which are organized into four groups, are included in Volume 4. Volume 5 presents data for twenty-four groups of nonmetallic solids. Volume 6 contains the critically evaluated and recommended values for 56 fluids organized into four groups.

In Volume 3 of the Retrieval Guide there are 6,978 references on specific heat, i.e., 20.7 percent of the 33,700 references. If the past ratio remains the same, there will be 1,240 new documents per year on specific heat entering the System.

d. Thermal Diffusivity

Thermal diffusivity will constitute Volume 10 of the new TPRC SERIES. The work on this property has been greatly accelerated and all the previous tables have been extensively updated and revised and new research documents are being processed. There are 597 documents on thermal diffusivity in the Retrieval Guide, i.e., 1.7 percent. About 100 new documents enter the System each year.

e. Thermal Expansion

Thermal expansion will constitute Volumes 12 and 13 of the new TPRC SERIES. The work on this property had been active in 1964-66, and suspended

until mid 1968. This work has been reactivated and Volumes 12 and 13 will be published in early 1971.

f. Viscosity

Viscosity will constitute Volume 11 of the new TPRC SERIES. The work on this property had been suspended from 1964 to 1966. Starting early 1967, this work was reactivated in TPRC's European Branch at the Belgian Institute for High Pressure, Brussels, Belgium, with Dr. P. Hestermans as Senior Investigator. This Volume 11 is planned to be published in early 1970.